WATER WORKS & SEWERAGE

August, 1936 — Editor — Volume 83. No. 8

IN MIDLAND MICH

MIDLAND COUNTY COURT HOUSE

Located near the central section of the Southern Peninsula, on the Tittabawassee River, Midland is both an agricultural and industrial center. Its manufactured products include chemicals, butter, powdered and condensed milk, toys and tools.

Midland's outstanding industrial organization is the internationally famous Dow Chemical Company. In its huge factories shown on the right are manufactured several hundred chemical products. Most of the raw materials employed, including all of the intermediates used in the manufacture of important medicinal salicylates, are produced within the plant. The resources, experience and knowledge of this vast organization, including a staff of two hundred graduate chemists, are available to anyone interested in the use of chemical products.

The modern water department at Midland is amply prepared to supply its 2,200 customers with pure water. PITTSBURGH Meters are used in the 100% metered system. Of the 360,000,000 gallons annual pumpage, approximately 80% is accounted for, not allowing for fire loss, sewer flushing, street washing or other municipal usage.

AERIAL VIEW DOW CHEMICAL PLANT - MIDLAND

MIDLAND CITY WATER PLANT

PITTSBURGH EQUITABLE METER CO.
MERCO NORDSTROM VALVE CO.
MAIN OFFICES PITTSBURGH PA

LOS ANGELES	KANSAS CITY	NEW YORK	PHILADELPHIA
OAKLAND	BUFFALO	ATLANTA	COLUMBIA
HOUSTON	CHICAGO	TULSA	MEMPHIS

PITTSBURGH WATER METERS

ABC DESIGN · CONSTRUCTION · COLLECTION
TREATMENT · DISTRIBUTION · DISPOSAL ABP

TOUGH, ductile and stubbornly resistant to impact, U. S. Super-de Lavaud Cast Iron Pipe, *centrifugally cast in a metal mold without chill,* is available with bell-and-spigot, flexible or mechanical joints for water, gas and sewerage service; with threaded ends in steel o. d. sizes for waste, vent and drainage service; and with the standard Ni-Resist alloy, approximating 14% nickel, 6% copper and 2% chromium, for oil refineries, process industries, mining operations, or wherever super-corrosives are used or encountered. Our laboratories and technicians are continually at work to the end that our service to public utilities and industry shall be improved and extended.

U.S. cast iron PIPE

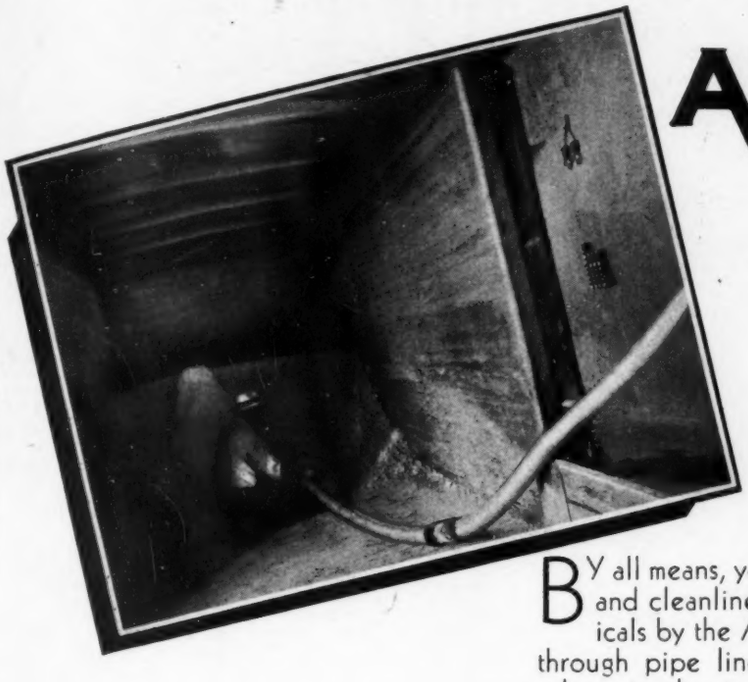
Cast iron and alloy cast iron pipe centrifugally or pit cast—for water works, gas, sewerage and drainage service as well as industrial uses involving corrosives.

U. S. PIPE & FOUNDRY CO.
BURLINGTON, NEW JERSEY
Foundries and Sales Offices throughout the U. S.

SUPER-DE LAVAUD CENTRIFUGAL CAST IRON PIPE

U. S. Pit Cast Pipe U. S. Threaded Cast Iron Pipe U. S. Mechanical Joint Pipe
U. S. Ni-Resist Cast Iron Pipe U. S. Flexible Joint Pipe U. S. Cast Iron Culverts
Alloy and Gray Iron Castings U. S. Cast Iron Roof Plates

SAFE
SANITARY
EFFICIENT
ECONOMICAL



The AIRVEYOR

Unloading lump lime at a mid-western water-purification plant. Note the particles range from dust to large lumps. The warning signals, which indicate when the bins are full, can be seen on the wall of the building.

BY all means, you should consider the economy, efficiency, and cleanliness of unloading and conveying bulk chemicals by the Airveyor system. This method of conveying through pipe lines to storage and process bins has many inherent advantages, some of which are:—

Several kinds of material can be handled alternately without danger of contamination, as the Airveyor is self cleaning

No dust hazards . . . workmen are not exposed to the danger of silicosis

Available in a wide range of types and capacities to suit all local conditions of conveying

In old plants . . can be installed without interfering with present operations

In new plants . . . enables the engineer to design a plant flow sheet practically without regard to the conveyor . . . material can be conveyed anywhere you can run a pipe.

Write for our bulletin on the Airveyor . . a penny postcard will do . . . no obligation of course.

FULLER COMPANY

CATASAUQUA, PENNSYLVANIA

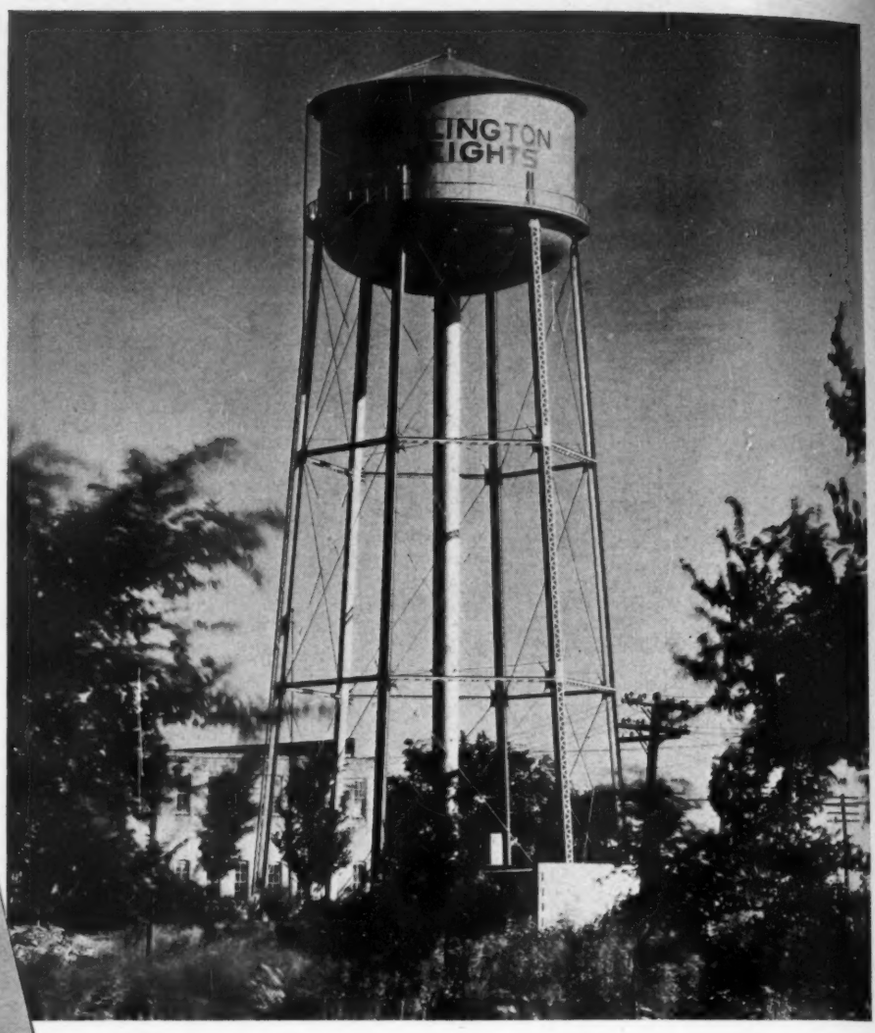
Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

A-8

FULLER-KINYON, FLUXO, AND AIRVEYOR CONVEYING SYSTEMS . . . . ROTARY FEEDERS AND DISCHARGE GATES
ROTARY AIR COMPRESSORS AND VACUUM PUMPS . . . AUTOMATIC BATCH WEIGHERS . . . BIN SIGNALS

WATER WORKS AND SEWERAGE, August, 1936, Volume 83, Number 8. Published monthly at 400 West Madison Street, Chicago, Ill., by the Gillette Publishing Company. Per Copy, 25c. Subscription rate, $2.00 per year; Canadian and Foreign, $3.00 per year. Copyright, 1936. Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

Helping Water Works Engineers to Write the Story



ELEVATED STORAGE AT ARLINGTON HEIGHTS, ILL.

The Horton ellipsoidal-bottom tank shown above has a capacity of 250,000 gals. Height to bottom of tank is 100 ft. Normal pressure variation in distribution system is only 2 lbs.

●

**Several of these reports are contained in recent reprint entitled: "Improving Water Service by Elevated Tanks and Booster Pumps." Ask for a copy—no obligation.*

THE story of improved service and lower pumping costs, made possible by elevated storage, is one that never ends. All over the country, more and more water works engineers are adding their experience to the record. Invariably, they report important benefits gained through the installation of properly designed tanks.*

In most cases, greater uniformity and reliability of water pressure is the most valued improvement. Lower pumping costs made possible by the maintenance of uniform pumping rates have been especially helpful to many cities, particularly during recent years. Similarly, concentration of pumping during off-peak periods when power rates are lowest has frequently reduced costs. Ability to increase system capacity with minimum additional investment is another common benefit. Greater protection in case of fire with a resultant lowering of insurance rates is still another benefit often reported following erection of Horton Tanks.

Adding your city to the list of those now enjoying the benefits offered by properly designed elevated storage tanks need involve no difficulties. We will be glad to send complete data and information on installations of every size and type to any municipal official, engineer or consulting engineer interested in this subject. Write our nearest office.

CHICAGO BRIDGE & IRON WORKS

Chicago.....2198 Old Colony Bldg.	Dallas.1479 Dallas Athletic Club Bldg.	Houston.....2919 Main St.	Boston.1548 Consolidated Gas Bldg.
New York.3390-165 Broadway Bldg.	Birmingham...1586 North 50th St.	Detroit.....1551 Lafayette Bldg.	San Francisco....1083 Rialto Bldg.
Cleveland....2262 Rockefeller Bldg.	Tulsa.....1646 Thompson Bldg.	Philadelphia..1644-1700 Walnut St.	Los Angeles...1455 Wm. Fox Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM, and GREENVILLE, PA.

Days CAN NOW BE SAVED

IN THE LAYING OF BELL and SPIGOT PIPE

SINCE the advent of *Tegul*-MINERALEAD it is no longer necessary to let trenches stand open for days or weeks, waiting for joints to heal and leaks to stop.

Joints made with *Tegul*-MINERALEAD meet any reasonable specification as to leakage *immediately after they have been poured.* Initial leakage is cut down as much as 97%. Trenches can be filled in almost at once. Traffic hazards due to construction work are minimized. Premises can be tidied up quickly . . . surely a welcome change from the old order of main laying.

Tegul-MINERALEAD proved a success from its introduction and is winning more and more friends every month. Its cost is but slightly higher than that of jointing compounds without its advantages. The experience of scores of users leaves no question as to its eventual economy.

Would you like more information—with special reference to the job you have in mind? We'll be glad to send it on request. Address: The ATLAS MINERAL PRODUCTS COMPANY of Pennsylvania, MERTZTOWN, Pennsylvania.

OTHER IMPORTANT ADVANTAGES . . .

Tegul-MINERALEAD comes molded in 10-lb ingots. Properly compounded at our plant, and shipped in this form, it cannot change in transit through the settling of heavier particles.

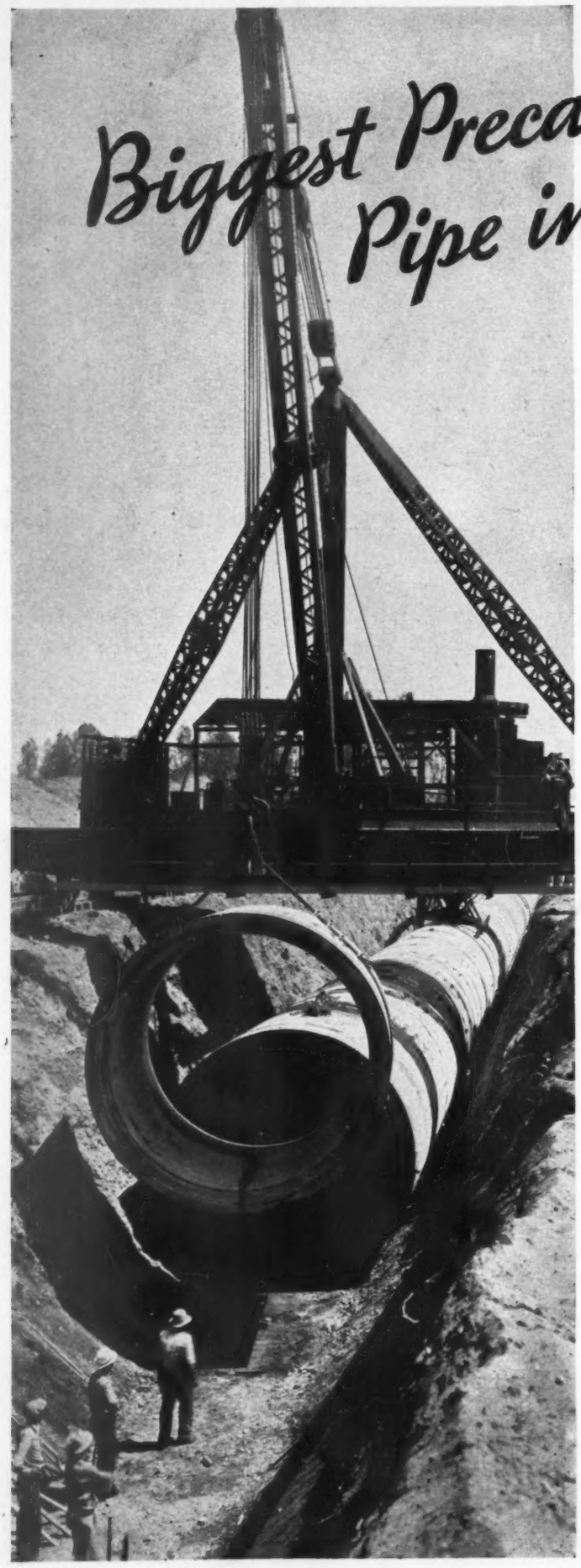
The ingots are convenient to handle and store on the job. The sudden downpour which would damage jointing compound in powder form, runs off *Tegul*-MINERALEAD ingots like water off the proverbial duck's back. Floods in the James River, Va., last Spring covered a stock of thousands of pounds of Tegul-MINERALEAD and, receding hours later, left it unharmed.

Tegul-MINERALEAD is permanent—does not deteriorate nor weaken with age; is much more elastic and much more resistant to mechanical and thermal shock.

●

ATLAS MINERAL PRODUCTS COMPANY
of Pennsylvania
MERTZTOWN ● PENNSYLVANIA

Tegul-MINERALEAD



Biggest Precast Concrete Pipe in the World!

12 ft. 8 in. precast concrete pipe. Colorado River Aqueduct. The Metropolitan Water District of Southern California. F. E. Weymouth, Chief Engineer.

Wide adaptability of concrete pipe again shown on job having many interesting features

AS PART of the Colorado River Aqueduct into Los Angeles, the Metropolitan Water District of Southern California is laying 50,762 feet of precast concrete pipe having an internal diameter of *12 ft. 8 in.!* Also 33,457 feet of 11 ft. 8 in. pipe.

This record size pipe has a shell thickness of 13 inches, the 12-ft. sections weighing 43 tons each. Operating heads vary from 40 to 80 feet. Capacity is 750 cu. ft. per second.

Pipe is placed in trenches varying from 18 to 29 feet in depth. Circumferential reinforcing is placed one-third circular near the inner surface and two-thirds elliptically.

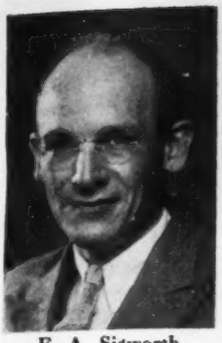
Laying of pipe is being done efficiently with a derrick gantry crane of special design. Lower 100 degrees of the pipe bedded in foundation concrete. Line and grade established and controlled at the invert. Pipe sections drawn tight together and joints carefully made with portland cement mortar.

A well-engineered, well-constructed job! And because the pipe is concrete, officials know that it will serve safely, efficiently and economically over a long period with a minimum of maintenance and maximum of flow capacity.

This $220,000,000 project includes hundreds of miles of concrete tunnel lining, siphons, conduit sections and canal lining. When tremendous sums are at stake, in water supply and sewer projects, concrete is the answer to a wide range of problems.

PORTLAND CEMENT ASSOCIATION

Dept. A8-29, 33 West Grand Avenue
Chicago, Illinois



E. A. Sigworth
Technical Sales Staff

DURING drought periods there is always an accumulation of taste- and odor-producing compounds due to low water.

Summer months usually call for much road construction and a subsequent use of tar oils and other phenolic compounds. The first rains after the dry conditions furnish a means of washing these taste- and odor-producing compounds into surface water supplies.

Troubles will be encountered with stagnant water from swampy area run-offs. Color bodies from the decomposition of leaves, grass, etc., make the task of purification more difficult.

Spills from industrial plants accumulated on headwaters will also be washed into streams from which raw water supplies are drawn.

CLEAR *Sailing* AHEAD

E. A. Sigworth

PHENOLIC COMPOUNDS—AQUA NUCHAR should be applied freely, either on the filters or in a split treatment if high dosages are necessary. Prechlorination should be discontinued in favor of post-ammoniation and post-chlorination.

COLOR REMOVAL—The application of AQUA NUCHAR prior to coagulation has been found to be quite an aid. The high alum dosages usually necessary can quite often be reduced.

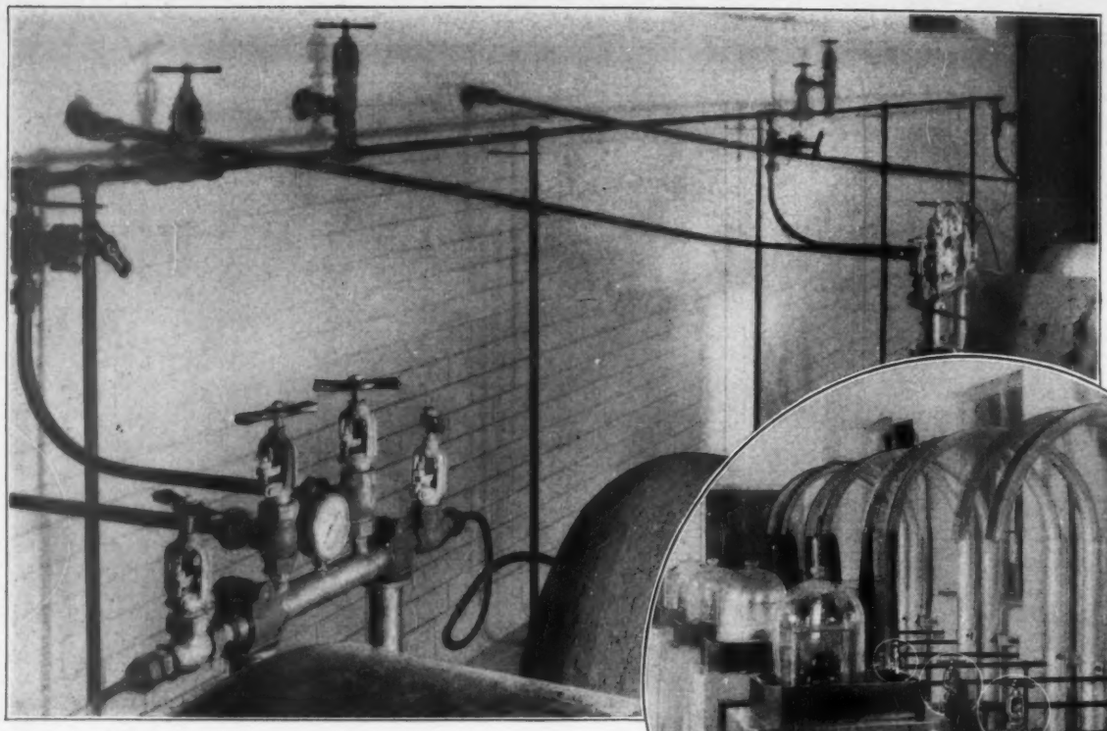
INDUSTRIAL WASTES—Usually pre-chlorination followed by dosages of 50 to 100 lbs. of AQUA NUCHAR (per million gallons) in split treatment has been found to be an effective means of taste and odor elimination from these sources.

Type of waste should be determined beforehand as frequently pre-chlorination on specific wastes has been found to be a cause of taste intensification. Write to E. A. Sigworth for any specific information required.

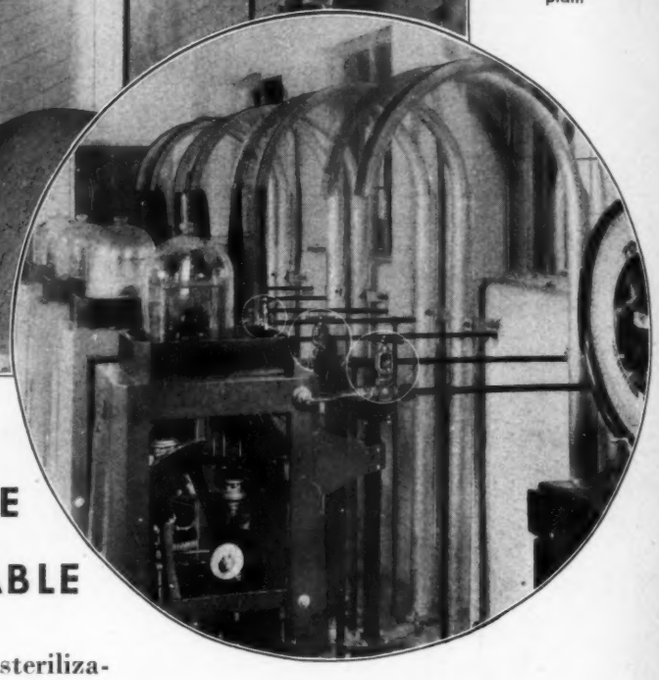
THREE PLANTS AND TWENTY-SEVEN WAREHOUSE STOCK POINTS TO SERVE YOU DURING SEVERE TASTE AND ODOR EPIDEMICS

INDUSTRIAL CHEMICAL SALES COMPANY, INC.

230 Park Avenue, New York. 205 West Wacker Drive, Chicago, Ill. 418 Schofield Bldg., Cleveland, Ohio.



Crane Chlorine Valves in modern water treatment plant

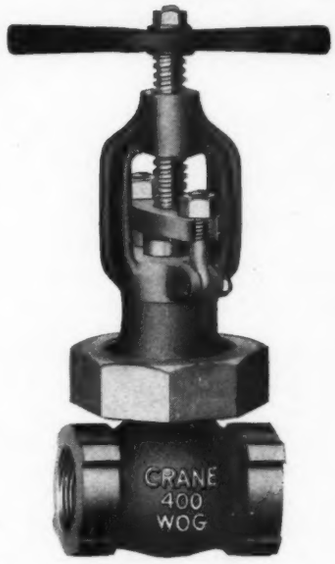


WHERE *Health* IS AT STAKE
VALVES MUST BE DEPENDABLE

● The dependability that is so essential in the sterilization of water by chlorination is fully met by the Crane line of valves for controlling chlorine gas.

Unusual care was taken in designing these valves to insure positive control, long maintained tightness, and ready accessibility to all parts. Special alloys are used for the valve stems, discs and seats to resist effectively the corrosive action of moist or water-laden chlorine.

Protect your community's water works, purification plant, sewerage-disposal plant and water-distribution system by standardizing on Crane valves and fittings. The far-flung network of Crane branches and distributors puts an unusually quick and efficient service at your disposal. Call the nearby Crane representative.



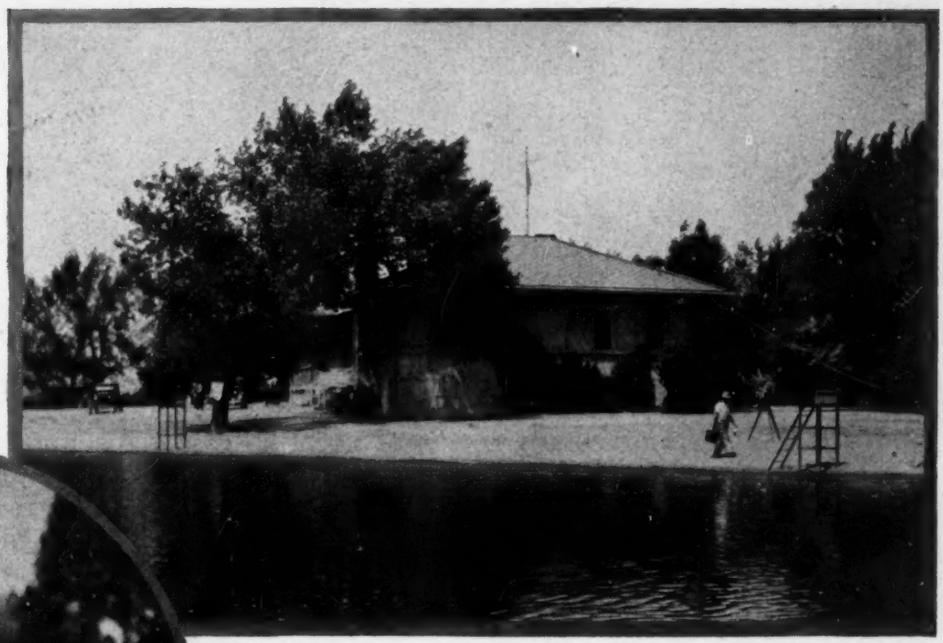
CRANE

CRANE CO., GENERAL OFFICES: 836 SOUTH MICHIGAN AVE., CHICAGO, ILL. • NEW YORK: 23 W. 44TH STREET

Branches and Sales Offices in One Hundred and Sixty Cities

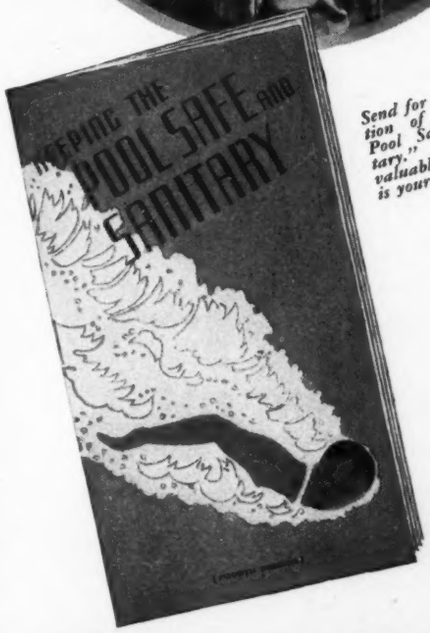
VALVES, FITTINGS, FABRICATED PIPE, PUMPS, HEATING AND PLUMBING MATERIAL

DENVER'S POOLS KEPT SAFE WITH HTH AND POWER SPRAYER MOUNTED ON TRUCK



George J. Turre, Chief Chemist and Asst. Supt. of Filtration at Denver, standing on running-board of truck trailer on which is mounted a high-pressure power sprayer for spraying HTH solution on sand beaches and entire premises of three municipal pools.

Washington Park bath house and bathing beach, Denver, Colo., one of three municipal pools kept safe by spraying with HTH solutions.



Send for the 1936 Edition of "Keeping the Pool Safe and Sanitary." A copy of this valuable 24-page booklet is yours for the asking.

THE City of Denver, Colo. takes no chances with the health of bathers at its municipal pools. Positive protection is assured by the use of HTH in conjunction with a mobile power sprayer that spreads the HTH solution throughout the swimming area and into every corner of the bath houses and premises.

Describing this equipment, Mr. Turre says: "The mixing tank contains 400 gallons of HTH solution. The spraying truck is equipped with 400 feet of high pressure rubber hose; with this extra length of hose it is possible to park the outfit in a suitable location, stretch out the long length of hose and spray more conveniently the piers, diving platforms, runways, etc. We find the above equipment very useful in spraying the sand which covers the beaches, also the interior of the bathhouse, the dressing rooms, lockers, shower and toilet rooms, floors, etc."

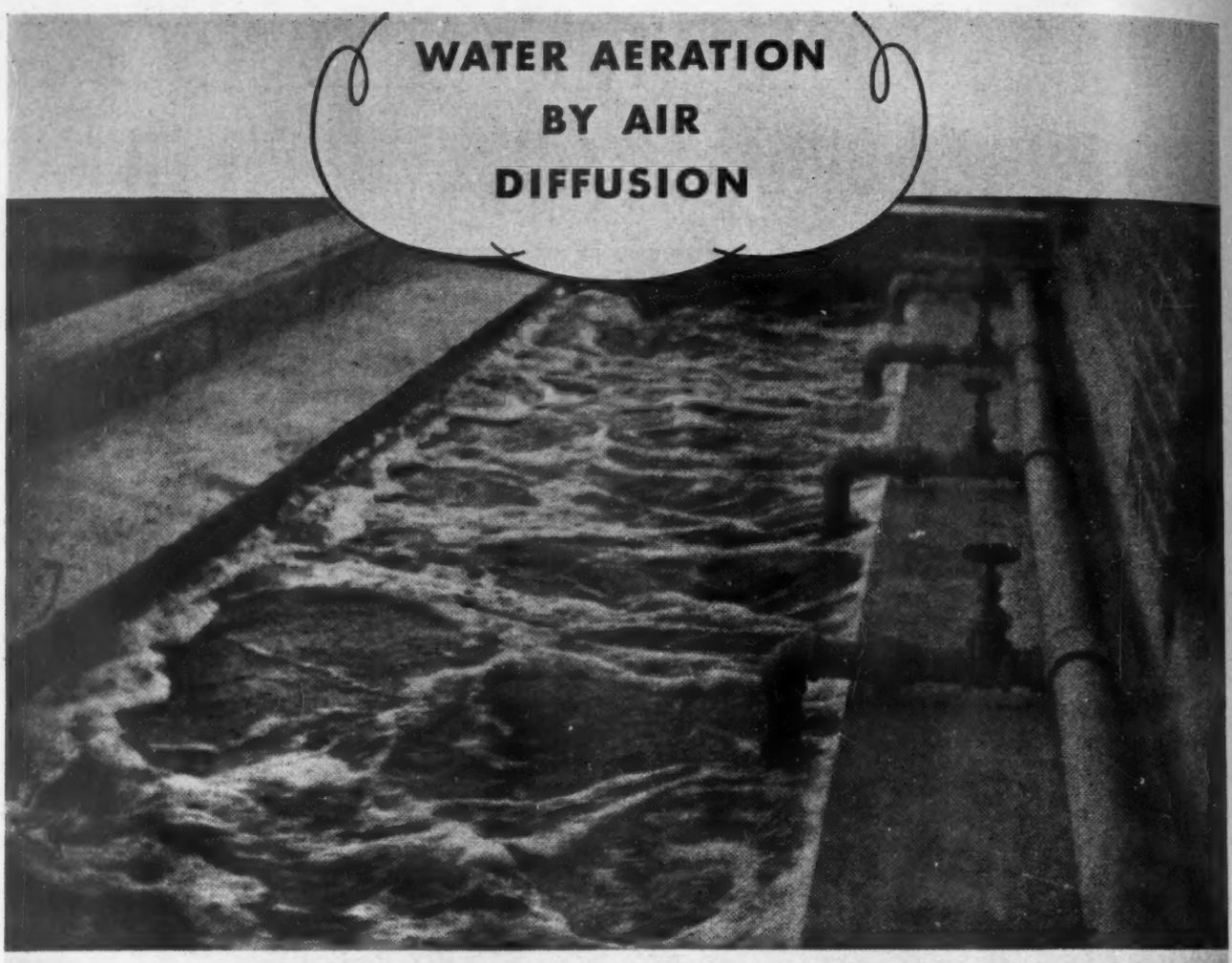
"HTH is found to be particularly effective and convenient in the protection of the bather from the transmission of certain infections."

The MATHIESON ALKALI WORKS (Inc.)

60 East 42nd Street **New York, N. Y.**

Soda Ash . . . Liquid Chlorine . . . Bicarbonate of Soda . . . HTH and HTH-15 . . . Caustic Soda . . . Bleaching Powder . . . Ammonia, Anhydrous and Aqua . . . PH-Plus (Fused Alkali) . . . Solid Carbon Dioxide.

WATER AERATION BY AIR DIFFUSION



Aeration tank at Huntingburg, Ind. water treatment plant. Charles Brossman, Consulting Eng., Indianapolis. An Aloxite Brand Installation.

AN ECONOMICAL and effective method of reducing carbon dioxide, releasing hydrogen sulphide and other odors, and oxidizing iron or manganese as well as an efficient method of mixing chemicals.

Further advantages:

- Flexible operation.
- No loss of head through aeration units of a plant.
- Combines aeration and mixing.
- Simple and low cost construction.
- Not affected by freezing weather.

For further details of design, operating data or discussion of any water aeration problem, write our Sanitary and Filtration Department.

And for greatest efficiency in water aeration plants specify—

ALOXITE BRAND DIFFUSER PLATES AND TUBES

REG. U. S. PAT. OFF.

products of

THE CARBORUNDUM COMPANY

NIAGARA FALLS, N. Y.

CANADIAN CARBORUNDUM CO., LTD., NIAGARA FALLS, CANADA

(Carborundum and Aloxite are registered trade-marks of The Carborundum Company.)

FIRST IN THE COUNTRY

SCULPTURED IN METAL BY L. L. BALCOM

"DR. LIVINGSTONE, I PRESUME" . . .

. . . is a phrase that will last forever in the hearts of all who worship courage, fortitude and the spirit of adventure. For it is the phrase that climaxed Stanley's great expedition into the Dark Continent in search of the lost explorer and missionary. A similar expedition into a dark continent of American industry was made in 1909 by EBG engineers when they produced Liquid Chlorine for the first time in the U. S. A. Since then EBG has shown again and again this pioneering spirit — by being first to adapt the use of Liquid Chlorine to textile bleaching, paper bleaching, shellac bleaching — and most important of all to the health and well being of the nation — to the purification of water supplies and the treatment of sewage.

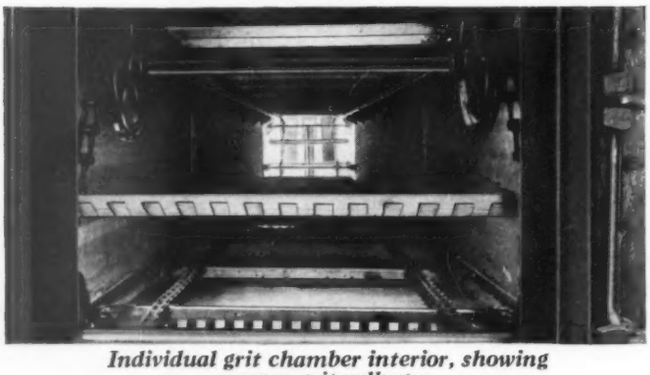
ELECTRO BLEACHING GAS COMPANY, MAIN OFFICE: 9 EAST 41st STREET, NEW YORK, N. Y. • PLANT: NIAGARA FALLS, N. Y.

EBG Liquid Chlorine

HOW TO HANDLE IT IF *IT* IS GRIT

REX GRIT COLLECTORS AND WASHERS SELECTED FOR THE NATION'S CAPITAL

Exterior view of washed grit-house taken from slab covering eight grit chambers.



Individual grit chamber interior, showing scraper grit collector.

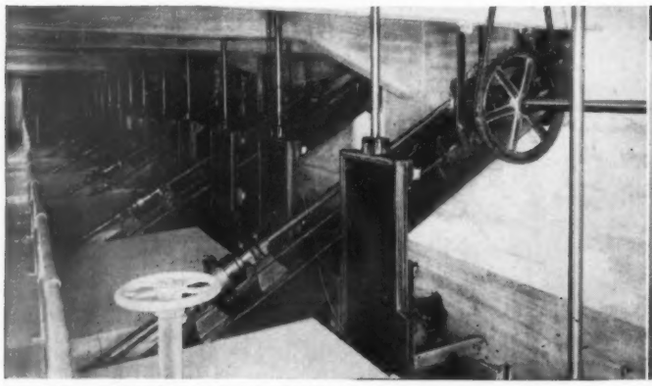
● In Washington, D. C., as in many other large cities, Rex Grit Collectors and Washers were selected for the important and difficult job of collecting detritus, and for washing it to render it suitable for easy disposal as fill at any convenient point.

Chain and Scraper Collectors are installed in the eight longitudinal grit chambers as well as in the two transverse distribution channels. Ten double-screw washers elevate the grit and discharge it in clean, non-putrescible, and well-drained condition.

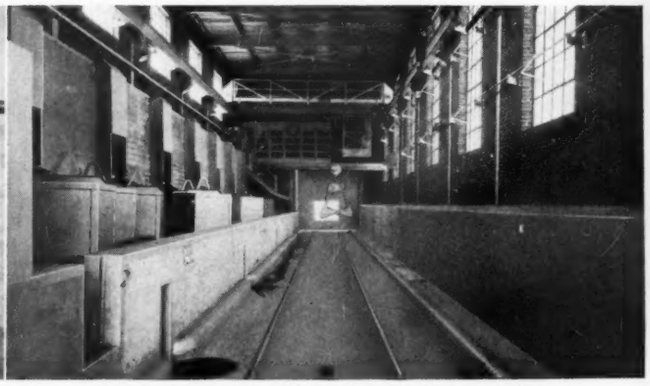
Rex Grit Collectors with separate Rex Grit Washers provide definite control of the intensity of the washing action to give clean grit even with an initially high organic content.

By separating the two functions of grit removal and grit washing and making each of the most suitable design, a wide range of capacity and flexibility has been secured for each operation.

This method of handling is especially desirable in smaller plants. Separate, controlled washing insures satisfactory grit regardless of fluctuations in flow and nature of detritus. Complete information will be sent upon request.



View of eight inclined double screw grit washers and influent gates.



Washed grit-handling room. Discharge from eight screw washers on left.

REX

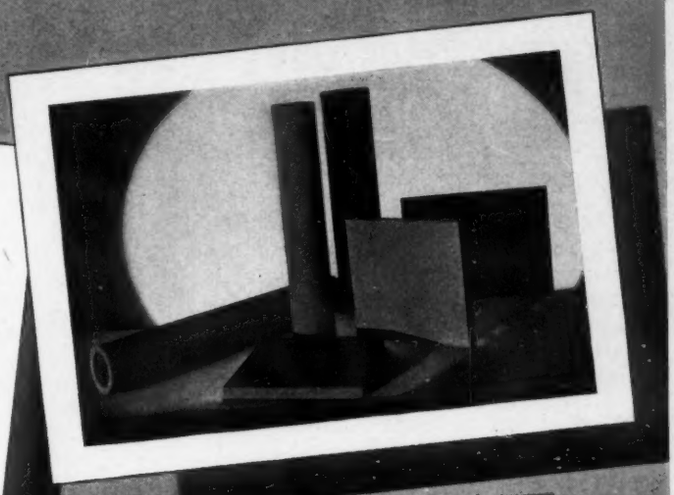
CHAIN BELT COMPANY
of MILWAUKEE

Sanitation Equipment

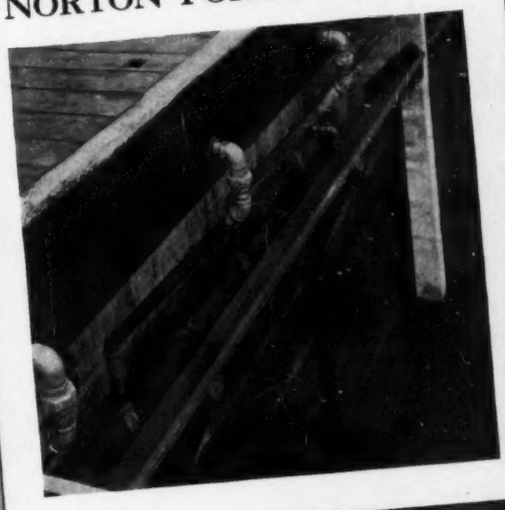
Meeting the Requirements of Activated Sludge Plants

THERE are no substitutes for experience and for proved performance. That is why more and more engineers are specifying Norton Porous Mediums.

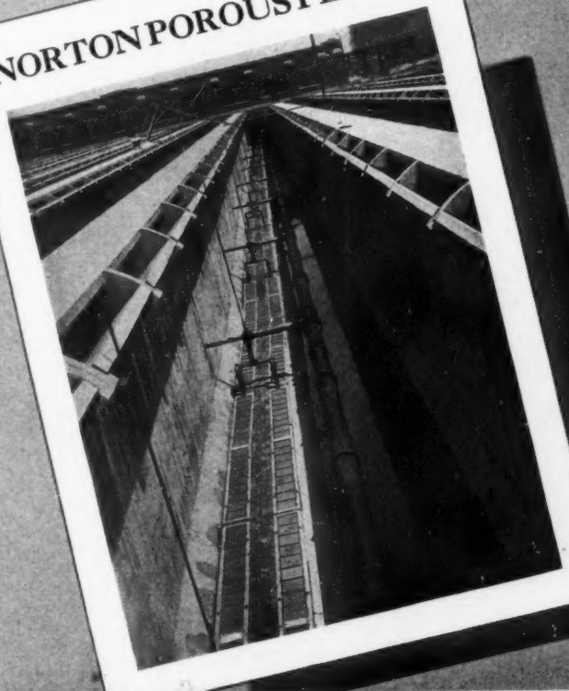
Experience. Norton Company has had over fifty years' experience in the manufacture of ceramic products and over thirty years' experience in the production of electrically fused alumina. Norton engineers developed the ceramically bonded, fused alumina porous medium and have nearly ten years' experience in meeting the individual needs of activated sludge disposal plants.



NORTON POROUS TUBES



NORTON POROUS PLATES



Proved Performance. In over a score of communities from coast to coast and in far distant countries Norton Porous Mediums are in extensive use—not a few experimental tubes or plates—but in use by the hundreds and even by the thousands in some plants. And their service is measured in years —periods that prove without question the ability of Norton Porous Tubes and Plates to give long, dependable performance.

Complete information on request.

NORTON COMPANY, Worcester, Mass.

NORTON POROUS MEDIUMS

Diaphragm Pendulum Unit Operation of Filtration Plant Gauges Has Many Advantages:

1. No mercury to be lost by sudden high pressures, excessive rates, or improper manipulation of valves.
2. Throat pressure is tightly sealed and can operate under a vacuum, permitting the Unit to be located below, level with, or even above the effluent pipe. (No pit in the pipe gallery floor is necessary for installation!)
3. If sand or sediment collects in diaphragm chamber, it can be easily blown out at the bottom tap without interfering in any way with the adjustment or operation.
4. One standard Unit can be used for various differential ranges by simply changing the length of the pendulum. The pendulum furnishes a means of resistance entirely unaffected by temperature, fatigue, or atmospheric conditions.
5. Overloads do not affect the accuracy. The diaphragm will stand pressures never reached in filter plant operation.
6. The accuracy can be checked easily by a standpipe giving artificial differential equal to half maximum rate.

Bulletin 240-A gives complete information.

BUILDERS IRON FOUNDRY

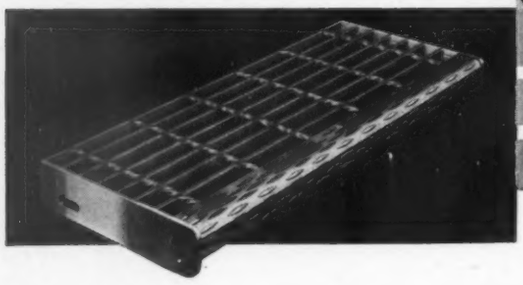
9 Codding Street **Providence, R. I.**

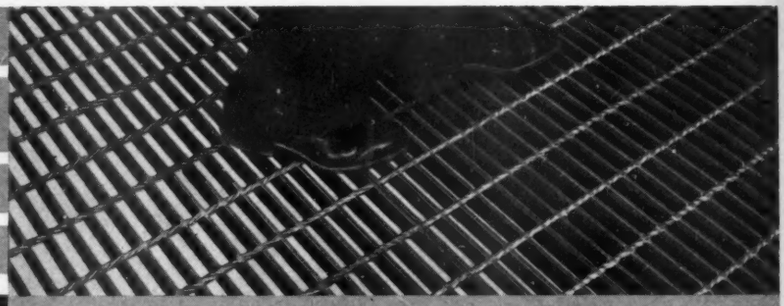
For Water Works and Filtration Plants

Venturi Meters for Main Pipe Lines; Venturi Rate of Flow Controllers; Builders Rate of Flow and Loss of Head Gauges; Venturi Manual Master and Clear Well Master Controllers; Chronoflo Long Distance Meters; Registers and Recorders for Open Flumes; and Chemical Feeders.

REPRINTED FROM WATER WORKS AND SEWERAGE—JULY, 1936

BLAW-KNOX *Electroforged* STEEL GRATING AND TREADS





ONE PIECE • NON-SLIP

SELF-CLEANING

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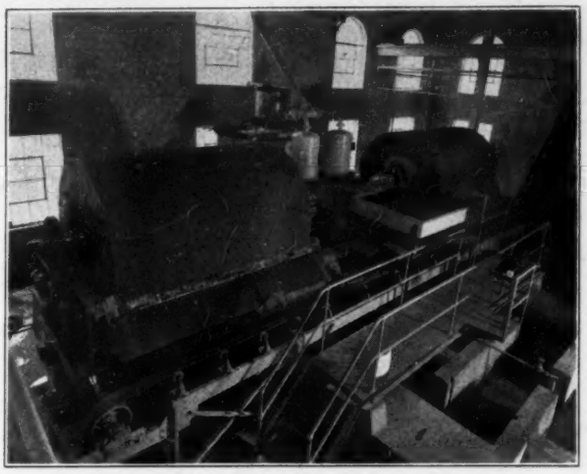

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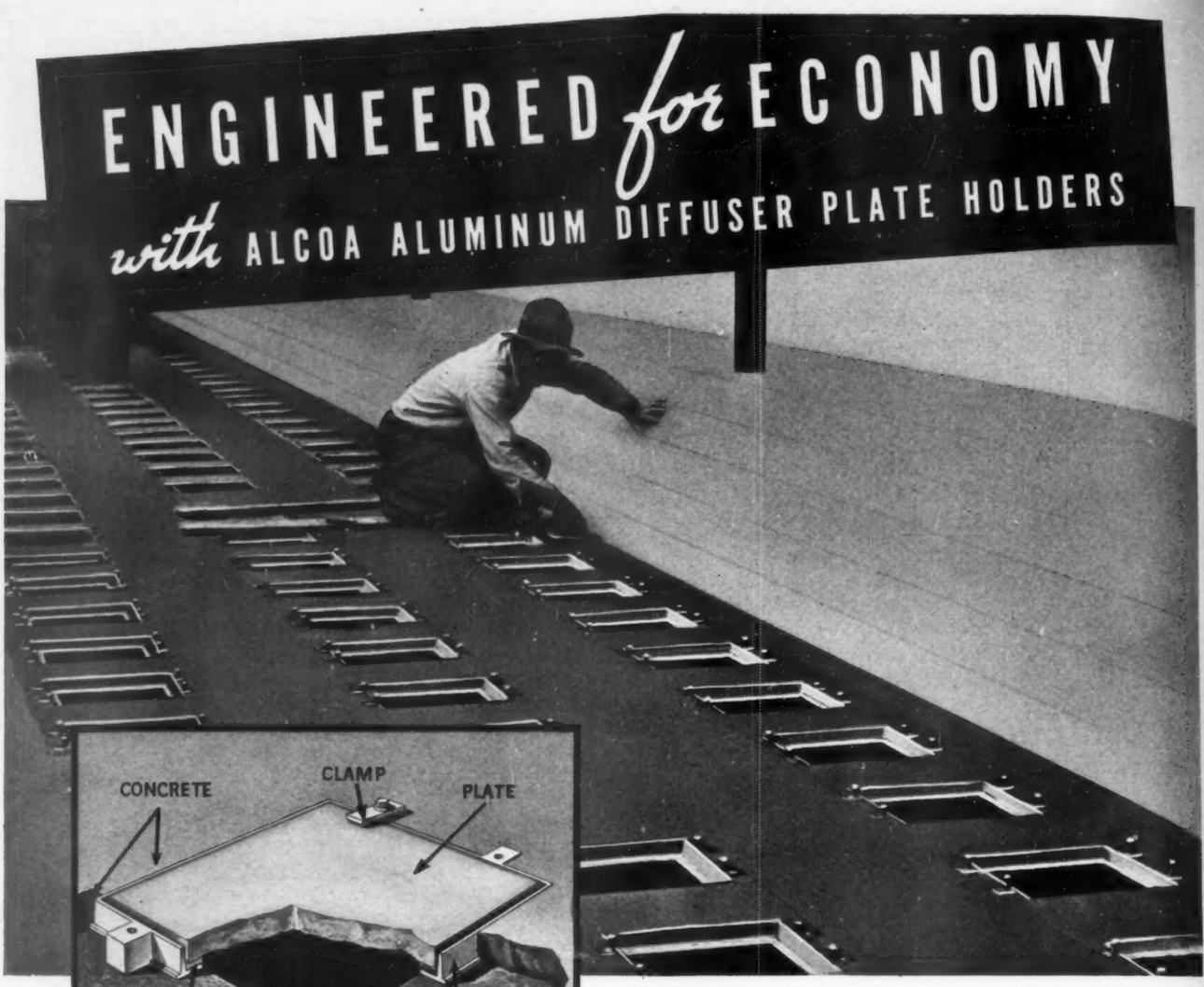

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WATER WORKS & SEWERAGE

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor

ARTICLES AND AUTHORS Scheduled for Future Issues

"The New Cermak Pumping Station"—By Loran D. Gayton, City Engineer, of Chicago, to appear in September, constitutes a description of the newest and most modern of Chicago's pumping stations, with emphasis on the unusual and novel features of design and operation.

Arthur E. Gorman and H. H. Gerstein in a companion article to appear in October, describe the arrangements and features of Chicago's newest Chlorinating station which has been especially designed for safety of chlorine handling, dependability of functioning and flexibility of operation.

"Venturi Flumes for Sewers"—By H. K. Palmer, Engr., Los Angeles County Sanitation Districts, describes the successful and economical permanent installations of Parshall-Venturi flumes within sewer-manholes for the purpose of measuring and recording flows. These flumes have not created obstruction or otherwise affected the service of the sewers so equipped; have proved entirely practical.

"Some Obervations From Corrosion Studies"—By Charles P. Hoover, Sup't. of Purification, Columbus, Ohio, reveals interesting and unexpected findings concerning water quality and resultant corrosion of household services and plumbing. In the experimental studies, dealing with waters treated by several different methods, the quality of waters assumedly of non-pitting nature have caused an unexpected degree of attack on hot water boilers and services. Other waters expected, from past conceptions, to be more aggressive have been the least so. The results indicate that there is much more to be learned about chemical balance for corrosion control. Water purification men will find that the Columbus observations throw a monkey-wrench into many accepted conceptions of corrosion control by water conditioning. Watch for this theory-upsetting article.

"Corrosion and Tuberculation Control by Deaeration"—By Sheppard T. Powell, Cons. Engr., and Dr. Bacon of Baltimore, Md., describes equipment used and experiences with a method of checking corrosion of a long and important water supply main, in which the aggressivity of the water is reduced by partial-vacuum deaeration to remove the bulk of the dissolved oxygen from the water.

"The A.B.C.'s of Electricity in Water Works Operations"—By Marsden C. Smith, Engr., of Water and Electricity, Richmond, Va., is to be the first of a series of short articles which will deal, in simple language, with the proper and economical use of electric power and operation and maintenance of electrical equipment in water works and sewerage plants. The author, an electrical-engineer converted to a water-works engineer, is thoroughly qualified to discuss electricity in the water works plant in this series of articles designed especially for the practical operator.

"Aero-Filtration of Sewages and Industrial Wastes"—By H. O. Halvorsen, Minneapolis, Minn., describes an improved process of sewage treatment which allows a super-loading of the time tested, economical and dependable sprinkling filter. The process involves high continuous application of sewage to the filter beds, with the aid of recirculation and forced drought of air upward through the stone beds, if and when needed.

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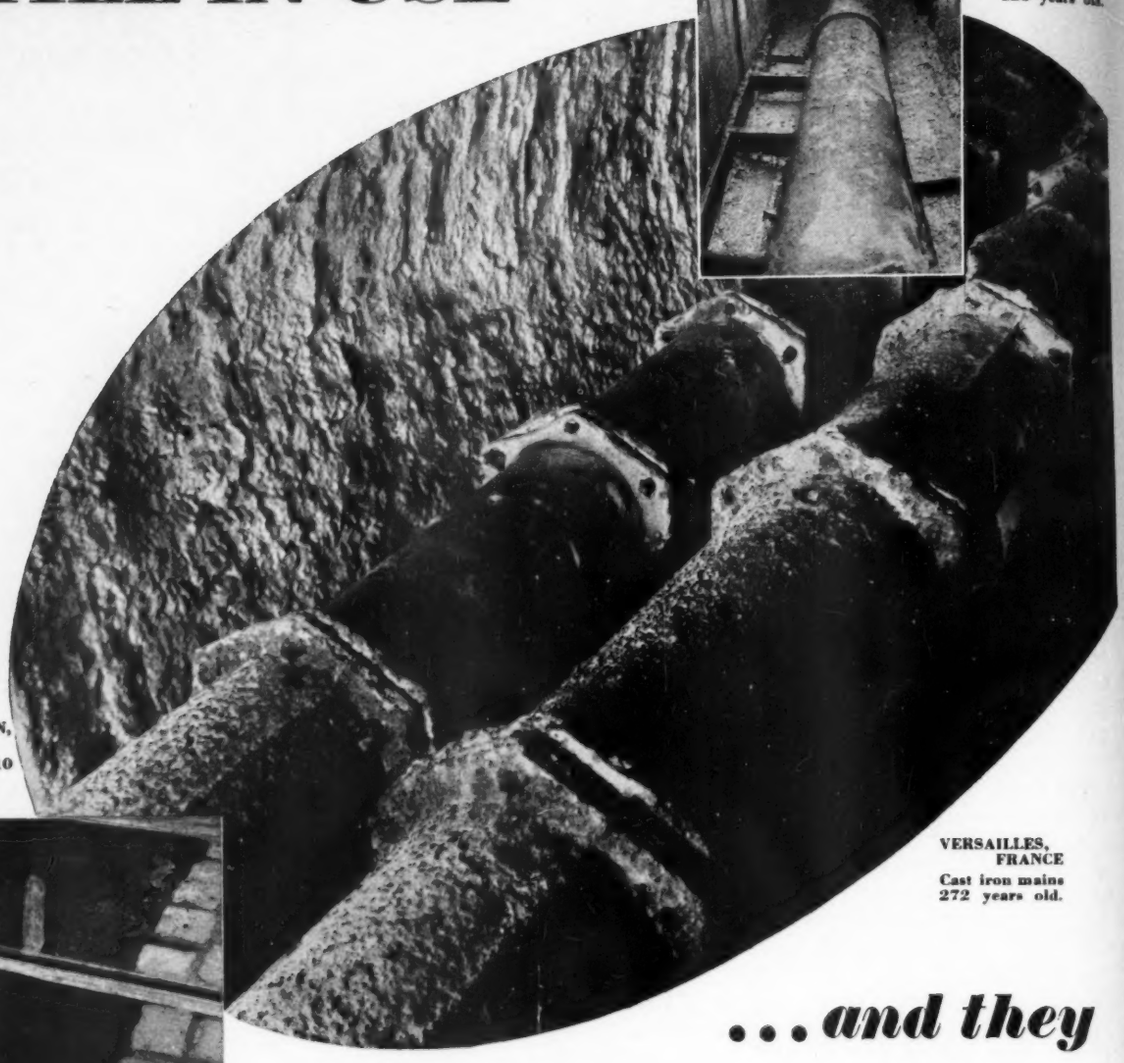

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WATER WORKS AND SEWERAGE

A GILLETTE PUBLICATION

VOL. 83 AUGUST, 1936 No. 8

EXPERIENCES WITH AUTOMATIC CONTROL EQUIPMENT AT PUMPING PLANTS

By H. A. HARRIS, Jr.

Operating Engr.
California Water Service Co., San Francisco, Calif.

THE trend in the past twenty years to supersede steam driven pumping equipment with electrically driven equipment is largely responsible for the development of automatic control.

Our company operates one hundred and forty pump stations in twenty-one water systems in California. These stations each contain from one to fifteen pumping units, the total number of pumping units being two hundred and sixty-seven. Of these, one hundred and eighty-two are production units—that is, connected directly to the source of supply—and eighty-five are booster units. All regular operating plants are electric motor driven, the three steam plants on the system are maintained only as standby equipment.

The general type of many of our California systems makes automatic control essential to economic operation. The usual system supplied entirely by wells consists of various well stations scattered throughout the area served. Systems of this type have developed in this manner for these reasons: First, the wide spacing of wells results in minimum interference between them; second, such spacing reduces the size of feeder mains required to distribute water.

In the past a system of the above type was operated by having attendants continually on duty at two or three key stations, and also having circulating or traveling operators to operate the balance of the stations. Whenever there was a failure of electric power the traveling operators had to visit all stations as rapidly as possible and restart all pumps.

With the perfection of the automatic reduced voltage starting compensator, these were installed in place of the manual compensators; the pumps then restarted automatically when power came on after a power failure.

In some cases, where several pump stations were located fairly close together, it was decided to extend control wiring from one central station to several outlying stations and start and stop these outlying stations from the control station in accordance with demands.

Types of Automatic Control

We operate three general types of automatic control —(1) float switch, (2) pressure of hydrostatic control and (3) electric time clock. These three are combined in various manners.

I believe that the best way to illustrate our various types of automatic control is to describe certain of our plants and their operation.

In nearly all cases where the pumps are near to a storage reservoir or a tank, we install a float switch in the reservoir and start and stop the pumps by means of the water level in the tank or reservoir.

At Bakersfield we serve a population of 35,000 and have a maximum daily consumption of 18 MG. We operate twenty-nine pumping plants with only two traveling pump operators. Twenty-two of the pumping plants are automatically controlled, most of which are controlled by a pressure governor.

The governor has contacts which are operated by pressure. The pressure at which it is desired to have the pump start is set and when the pressure drops to that point contact is made in the governor to the control wiring on the starting contactor and the motor is started. The pump then operates until the pressure reaches the high setting on the governor, at which point the governor circuit is automatically disconnected and the motor stops. Any form of relay which controls equipment as a function of pressure must be combined with some form of surge protection. We accomplish this by the installation of an air chamber in the pipe leading from the discharge main to the pressure governor. The entrance to the chamber is through a small orifice so that it takes several minutes for a change in the system pressure to reach the governor. In a system with a great many pumping units the governors are given various settings so they will cause the pumps to come on as they are required. The most efficient units are set to come on first and go off last, with other units coming on the line to meet maximum loads. A few stations, operating but a few hours each day, on peak demands, are manually controlled. In this type of system it is necessary to have altitude valves on storage tanks and reservoirs in order to prevent them from overflowing, and to release storage when required. The altitude valve is set to close at a full tank and reopen with a small drop in pressure on the system side of the valve.

At our Mallard pump station on the Sacramento River in Contra Costa County, we have three pumping units with a combined daily capacity of 25.5 M G. The control board is so wired that upon pressing the "start" button the units will start successively, with a definite time interval between the starting of each unit. This reduces the starting current required. The order of starting can be changed in any manner desired. In event of power failure, upon resumption of service the pumps will restart in the order previously set. On the 36 in. discharge line from this plant is a 24 in. Larner-

Johnson check valve which opens and closes slowly with starting and stopping of the pumps.

Surge Control

A surge chamber of special design is located on the line just outside the pump station. This surge chamber is designed so that it is closed when the pumps are operating and open when the pumps are stopped. The surge chamber is built with two compartments. The inner compartment is connected to the pipe line and the outer compartment to a waste line. There is a valve in the inner compartment which seats at the top of this compartment. A locking device holds the valve open when the pumps are stopped. When the pumps are started a solenoid in the motor circuit is energized and releases the locking lever on the valve. The valve then rises to its seat at the top, and is held there by the operating water pressure. With the stopping of the pumps the solenoid is de-energized and drops the locking lever into place, and the valve drops due to its weight and decrease of water pressure. When the valve drops into full open position the locking lever catches and holds the valve locked open until the pumps start again. The opening of the valve allows the surge to overflow the inner chamber into the outer and thence into the waste line provided.

Another very interesting automatic control is located in the Contra Costa District. In 1931 we constructed what is known as our San Ramon Valley line. This is 15 miles in length with two booster lifts, with storage tanks at the upper end of each lift. Two pumps are located in our Galindo Pump Station taking suction from a 400,000 gallon collecting basin. The pumps operate against a static head of 210 feet, and combined static and friction head of 250 feet. The second lift pumps take suction from a line out of the first storage tank, and operate against a static head of 270 feet and a combined static and friction head of 320 feet.

The control equipment on each of these lifts is the same and I shall describe one. On the switchboard is located a pressure governor and a magnetic contactor with incidental wiring and push buttons and an electric time relay. On the pump discharge line is a Larner-Johnson check valve, and on a tee taking off of the discharge line is a Larner-Johnson surge suppressor. At the storage tank is located an altitude valve of the type actuated by direct head from the tank.

The operation of this plant is then as follows: The pressure governor is set to make contact at a pressure corresponding to a drop of about 12 or 15 feet in the tank water level. As the pumps start, the Larner-Johnson check valve opens slowly, and the water moves up the seven miles of pipe line to the tank. Upon the filling of the tank the altitude valve closes, thus causing a pressure rise in the line and at the pump station. This pressure rise causes the pressure governor to break the contact, thus stopping the pumps. At the same time the check valve begins to close, due to pressure differential, the surge valve opens, due to pressure drop. Thus the return flow passes out through the surge valve and back into the line on the low side of the booster pump. The check valve closes in a period of about a minute, and the surge valve in from one to two and one-half minutes. The pressure rise is thereby held to only about 20 pounds above normal pumping pressure.

As an added safety feature, in case the pressure control fails to start the pumps within a two-hour period after a shut-down, a time relay will start them automatically and the operation will proceed as before.

Some difficulty was experienced in the beginning to get all parts functioning properly, particularly the check and surge valves; however, for the past five years these plants have been operating very successfully with a minimum of attendance.

Automatic Control for Flexibility

An entirely different type of control was installed to operate three pumping plants in one of the beach cities. Four pumping units pump into a distribution system upon which floats a 400,000 gallon reservoir. A ¼-in. pipe line was laid from the reservoir to the pump stations. Three of the units located reasonably close together are controlled by one board, while the fourth has its own board. The hydrostatic pressure is conducted to a mercury chamber in which there are a series of contacts. The relays and circuits are so connected, that with the water level in the reservoir falling, when the first contact is reached the first unit starts; when the second contact is reached a second larger unit starts and the first unit stops; the third contact starts the first and third units and stops the second unit; the fourth contact stops unit one and starts unit two while three continues to operate; the fifth contact starts unit one again with units two and three remaining on. This hookup provides automatically for five different rates of pumping with but three pumps. With a rising water level in the reservoir, the pumps go off in an order opposite to the one in which they were started with the falling water level.

We have a great many units controlled by float switches on tanks and reservoirs. This is a very positive method of control but proves somewhat expensive in first cost if the distance from reservoirs to pump station is much over one mile.

An Interesting Case

About three years ago we installed a booster station at Petaluma to take care of an extensive high level area. We were obliged to keep down first cost, and therefore had to use an available small tank for storage. The capacity of the tank was only four thousand gallons and the effective height only six feet. The booster station was located at the low service reservoir about six thousand feet from the high level tank. A survey showed that it would be very expensive to construct a float switch control line, due to the fact that the only available pole location was taken up by power, telegraph and telephone lines. We were quite skeptical of the ability of a pressure control system to operate successfully but decided to try it. An altitude valve was installed at the tank, and a pressure governor at the pump station. The governor was set to start the pump upon a drop of about three pounds below full tank pressure, and stop at a pressure several pounds above full tank pressure. When the tank is filled the altitude valve closes, thus causing a rise in pressure sufficient to break the governor circuit and stop the pump. Upon a sufficient drop in pressure the governor closes and restarts the pump. The reason for doubt about the successful operation was, that changing demands on the pipe line between the pump and tank would cause a variation in pressure at the tank for a fixed pressure at the pump, and might in some instances cause the tank to empty entirely before the pump would start. However, the operation of this plant has been entirely successful, much to our gratification.

Interlocking Control on Well Systems

We have a number of installations where six or eight well pumps discharge into a small collection tank, and a booster pump delivers the water to the central distribu-

tion reservoir. The usual installation in this case is to make the booster slightly larger in capacity than the combined well pumps. The traveling operator starts the required number of well pumps, and the booster is float controlled by a float in the collecting tank which starts the booster when the tank is nearly full and stops it before the tank is emptied.

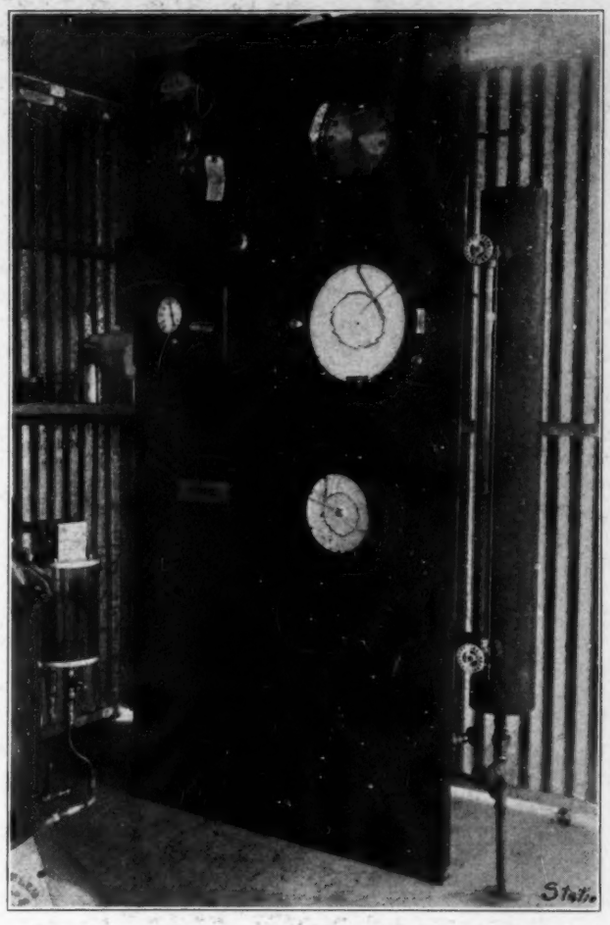
We have several wells where aeration of the water is necessary. The installation in these cases consists of a well pump, a cascade or other type aerator, and a small collecting basin. The operation is as follows: The basin is full at the beginning of the operation; the booster pump is started, when the drop in the distribution system pressure reaches the point set on the pressure governor for starting. When the water level in the basin reaches a point about two feet from the bottom, the float switch closes and starts the well pump, the well pump continues to run until the water reaches a point a few inches below the top of the basin, at which point the float switch opens and stops the well pump. For safety, a second float switch is set to stop the booster pump just prior to the basin becoming empty and to start the booster just before the basin overflows. If the well pump has a capacity slightly in excess of the booster, the well pump will stop and start automatically while the booster continues to run on its pressure control. However, if due to a change in conditions the booster should have a capacity in excess of the well pump, the booster is stopped by the second float switch, and is likewise automatically restarted by this switch in case the first switch failed to cut off the well pump before the collecting well overflows.

At San Mateo we have a well pump delivering water into a 100,000 gallon collection tank from which a booster pump takes water and delivers it into the system. The booster pump is normally controlled by a pressure governor on the distribution system pressure. Three float switches are installed in the collection tank.

A complete cycle of operation is as follows: About midnight the pressure in the distribution system will rise sufficiently to stop the booster pump. The well pump runs continuously and between 4 and 5 a. m. the tank fills to a point about 8 in. from the top; the first float switch will then start the booster pump, which continues to operate until the water is lowered to a point 16 in. below the top. If the booster should fail to operate, or should pump less water than the well pump is delivering, the second float switch will stop the well pump when the water level reaches a point 2 in. below the overflow, and will start it again when the water level has fallen 12 in. This procedure insures the tank being full of water in the morning when the system requires water, and also utilizes the well to its maximum capacity.

The booster will start about 7 or 8 o'clock in the morning, due to drop in system pressure, and continues to operate until the rise in system pressure stops it. If through a break in the distribution system, or failure of the well pump, the booster would otherwise empty the tank, the third float switch stops the booster and will not allow it to restart until there are 12 in. of water in the tank above the booster outlet.

To summarize the operation of this plant: The pressure governor operates the booster pump when water is most needed in the system; the float switch operates the booster to utilize the full capacity of the well and tank, the second float switch keeps the well pump operating and prevents the tank from overflowing; the third float switch prevents the booster from completely emptying the tank and running dry.



50 *HP. Standard Switchboard for Automatically Controlled Pumping Plant*

In the upper right-hand corner of the board is an 8-in. indicating pressure gage. Below this is a 12-in. recording flow-meter and below the flow-meter an 8-in. recording pressure gage. To the right of the panel board is a pressure chamber 6 in. in diameter and 36 in. long, which serves as a cushion on the pressure line leading to the pressure governor. On the upper left-hand corner of the board is the Power Company's integrating watt-hour meter and below that a General Electric pressure governor. Below the pressure governor are the push button controls by which the unit may be started automatically or by hand and also shut completely off. Below the push button stations is the main power circuit breaker, together with circuit breakers on the lighting and incidental equipment. Below the circuit breakers is the magnetic contactor.

A portion of the deep well turbine pump appears in the lower left-hand corner of the picture and this view shows quite clearly the automatic solenoid oiler on the pump. The flow of oil from this oiler to the pump bearing is started and stopped with the starting and stopping of the pump motor.

This switchboard here illustrated was designed by the California Water Service Co. and constructed by the Westinghouse Electric Company.

The well pump delivers continuously about 150 GPM and the booster supplies 300 to 400 GPM during peak demands, lasting about three hours.

Miscellaneous Cases

At Redding we have a pump station on the Sacramento River pumping river water to a reservoir about a mile and a half away. The pumps are controlled by a circuit connected to fixed metal disc contact in the reservoir. When the water falls to the level of the lower contact the pump is started, and when it rises to the upper contact point the circuit is broken and the pump stopped. An alum machine and a chlorinator located at this plant are stopped and started automatically by the control circuit on the main pump motors.

At Marysville are two large triplex reciprocating pumps driven by slow speed motors which pump water

to a storage tank located at the top of a four-story building. These pumps were manually operated for over forty years, and considerable doubt was felt that they could be successfully operated automatically. However, about six years ago a float switch control was installed from the tank to the pump station, and each of these Triplex units is operated by a separate float switch. A deep well turbine pump located more than a mile away is also controlled by a third float switch on this same tank. These units can be set to come on in any desired order by changing the float switch contact settings.

We have just recently installed a somewhat novel installation at San Carlos. This is a small plant with an average daily demand of 80,000 gallons. About 90 per cent of the supply comes from the San Francisco Water Department transmission line. A recent reduction of the pressure carried on this line made necessary the installation of a booster pump. We already had 100,000 gallons in storage capacity which was used to serve the low-level system; a first high-level area was previously served by San Francisco pressure directly without storage, and a second high-level section was served by the same pressure but had 40,000 gallons of storage. Due to high cost of real estate and the small quantities of water handled, our studies showed the most economical installation would be a booster station with a single unit which could pump to all three locations. An air pressure tank was installed on the same property as the low-level tanks, to serve the first high area. A check valve was installed on the line to this area. A check valve was also installed on the line leading to the second high-level storage. Two pressure governors were installed at the pump station, one connected to the air pressure tank line and one to the low level line. (The second high-level area is on this same line.) Action of either pressure governor will start the pump, but only when both are in off position will the pump be stopped. Due to high friction losses in the line to the low level tanks, we expect that sufficient water will go to the high-level tanks on the second high area while low-level tanks are filling. A time relay is also being installed on the control circuit so that the pump can be set to run during definite time intervals if such should prove advisable. This clock has two "on" points and two "off" points so that it can be set for two complete cycles of operation each day. When the clock is cut into the motor control circuit, the pressure governors cannot stop the pump while it is running during the set time intervals, but the governors control during the time between on "off" position and an "on" position on the time relay. This installation could be improved by the use of a float valve to shut off the low-level tanks, but due to a considerable quantity of old light weight steel casing in the distribution system, some concern was felt over installing such a valve, but this may be done later. Only experience in handling this station will show the necessary settings on pressure governors and time relay to give best operation.

We have quite a number of booster pumps operating in connection with air pressure tanks serving individual high-level areas of 25 to 400 consumers. All such pumps are controlled by the pressure in the air pressure tank. The usual range is about a 30 or 40 pound differential between "on" and "off." This type of installation has proved most satisfactory for this type of service.

At Redondo Beach we installed a booster station to pump from the low-level transmission main to a 50,000 gallon high-level tank. This pump was originally controlled by a pressure governor connected to the discharge main leading to the tank. Due to this line being small and the friction loss high, and having varying demands on the line between tank and pump, difficulty was encountered. This condition caused a wide variation in the pressure at the pump station for a given water elevation in the tank, and the tank was either overflowing or going empty. The most economical cure in this particular instance was to lay a ¾-in. line from the tank to the pump (a distance of about 2,000 feet), and connect the pressure governor directly to this hydrostatic line, thus eliminating the effect of friction. This installation has worked very well since this change was made. We have another installation very similar to this but utilizing a mercuoid switch instead of a pressure governor.

We have just completed the installation of a complete automatic control at two of our East Los Angeles plants. We have one well pump at a station which pumps to a receiving basin at another station. At the latter station is also a well pump discharging into the same basin. There is a float switch control on each pump. The pumps are started and stopped at set water level points in the basin. Each pump starts and stops at a different point. A booster pump located in the same station as the receiving basin is stopped and started by means of a float switch on a steel stand pipe located about 1,800 feet away. This standpipe is in balance with an elevated tank located almost a mile away. The water level in the elevated tank is controlled with an altitude valve, and for additional safety there is an overflow on the standpipe. There are six pump stations in addition to the two just mentioned pumping into the distribution system served by these same two storage tanks. Four are controlled by pressure, and two with time clocks which are set to operate them during hours of peak demands.

Economies from Automatic Control

The complete cost of providing automatic control in the two plants above was $1,900 and the annual saving $4,000. This well illustrates the economies which are possible. On well pumps controlled by float switch or time clock we provide definite time relays which prevent the pump from starting within several minutes after stopping. This is to insure that they will not be started while spinning in reverse. On those controlled by pressure governors sufficient time lag is provided by the air chambers previously mentioned.

To give a general idea of the extent of automatic control on our system, we have one hundred and four plants automatically controlled and thirty-six manually controlled. Of these thirty-six about twenty are used only as standby or for peak loads.

On our entire system we have only eight pump stations where we keep a full shift of operators on duty. At three of these are located filter and treatment plants which require the continued services of an attendant. A fourth is the Mallard Pump Station on the Sacramento River which is operated about four or five months out of the year. Of the remaining four we have tentative plans to change one to automatic control.

I wish to state here that our success in automatic control is due in no small amount to the development of very dependable electrical equipment in the line of magnetic contactors, relays, time clocks, pressure governors, float switches, etc. Another fair share of credit goes to makers of altitude and regulating valves. A small share of the credit we take for ourselves in proper design and adaptation of the above equipment to our specific problems.

We do have occasional failures in our automatic control, and certain installations have not operated as ideal-

ly as anticipated; but on the whole all of this equipment goes on operating day after day with no attention other than a reasonable amount of inspection and maintenance.

I believe the best test of our success in automatic operation is the fact that we operate 267 pumping units in 140 pump stations, located in twenty-one separate water systems, with a combined annual production of 14.2 billion gallons. The annual expense for pumping labor is $62,000. This represents a labor cost of $4.35 per MG, or $440 for each pump station operated. The total cost of maintenance of pumping equipment, including all automatic control, amounts to $7,500 annually, or about $28 per pumping unit. This annual maintenance figure is approximately three-quarters of one per cent of the capital invested in electric power pumping equipment.

Acknowledgment: The above paper was presented by Mr. Harris before the Los Angeles Convention of the American Water Works Association, June 8, 1936.

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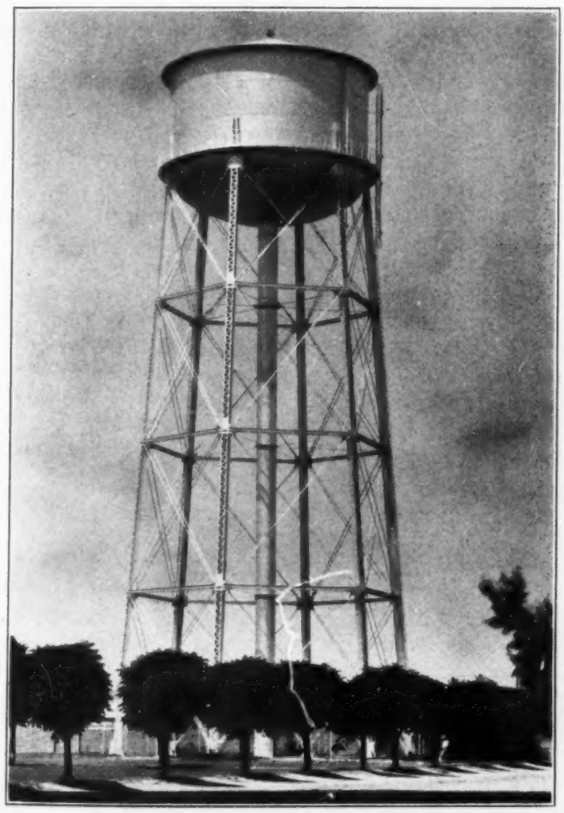
110 Feet High But 7 Feet Low (Believe It or Not!)

If built to the same elevation at Long Beach, California, this tank would hardly be recognized. There would be no tower at all. In fact, the bottom of the tank would be in the ground 7 feet or more.

At Brawley, Calif., however, where this tank is located, it is (as is plain to see) truly an "elevated" tank with its bottom 110 feet above ground level. But, in Long Beach the same actual elevation (sea level datum) is 7 feet or better beneath ground level. Therefore, we say that 110 feet "high" at Brawley is 7 feet "low" at Long Beach. Why? It is simply this: The ground level on which this tank stands in Brawley (Imperial Valley's thriving little metropolis) is all of 117 feet below sea level and although the bottom of the tank is 110 feet "up" it is also 7 feet "down" because it is actually still that much below sea-level.



The Brawley Tank

Although a perfectly satisfactory elevated tank and solving pressure problems for Brawley, if an all gravity pipe line were laid from it to the sea the water would "run uphill" to fill Brawley's "elevated" tank. What a power project this would make, except that Brawley might ask, "But, where would the water go after they are through with it?" And, what if the pipe line broke and the leak couldn't be located or stopped? Fortunately for Brawley and her sister cities of the Imperial Valley some nice thick mountains are between them and the Pacific.

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The Application of Copper Sulphate to Reservoirs Having Sloping Walls

By W. T. BAILEY*
Council Bluffs, Ia.

We rely mainly on chloramine for controlling growths of algae in open reservoirs[1]. However, we find at least two species that do not respond to chloramine, but which readily respond to copper sulphate treatment. Both are attached forms, growing along reservoir walls.

Until the spring of 1935 we used the time honored method of applying copper sulphate by placing several pounds of large crystal form in a burlap bag, dragging the bag along the reservoir walls. Three of our clear water reservoirs, having a theoretical capacity of approximately four days, have walls sloping at an angle of about forty-five degrees. It was observed that in making the application on these reservoirs holes would be worn in the burlap bags, permitting some of the crystals to fall along the wall where they slowly dissolved. Wherever this happened all traces of algal growths would be removed in a strip from where the crystal lay to the bottom of the reservoir. This suggested that a line of crystals along the reservoir wall at the water line would give best results for this type of growth, inasmuch as it would permit a very heavy concentration of copper sulphate to remain in contact with the attached growths for a much longer period of time than when the material was dragged along in a bag and wasted in the water above.

In order to make such an application the spout was cut off a two gallon watering can to such a length as to leave an opening approximately one inch in diameter. The can is filled with fine crystal copper sulphate and application made by walking along the reservoir coping, using a swinging motion on the can to keep a small stream of the crystals flowing; regulating the application by swinging the can more or less vigorously to secure the desired amount. The object being to secure an application such that the entire face of the wall will be swept by the dissolving copper sulphate as it sinks to the bottom of the reservoir. Our experience is that five pounds of small crystal copper sulphate satisfactorily covers one hundred linear feet of reservoir wall.

By making applications at intervals of ten days the walls of the reservoirs have been kept completely free from growths during the past two seasons. Of course we still rely on the burlap bag where the walls are vertical or nearly so. This method applies only to attached growths on walls sloping at such an angle that the crystals will lie along the water's edge.

[1] "Taste and Odor Control," W. T. Bailey, J. A. W. W. A., Vol. 27, 458.

*Chemist, Water Dept., Council Bluffs, Ia.

GOVERNMENTAL INVESTIGATION OF WEATHER CYCLES AND THEIR CAUSES

By HALBERT P. GILLETTE
Member American Meteorological Society

AT LAST our government has begun a research on weather cycles that bids fair to be a thorough one. Henry A. Wallace, Secretary of Agriculture, has just announced that funds have been allocated for this purpose from the Bankhead-Jones appropriation for researches affecting agriculture.

Apparently this research is sponsored by Mr. Wallace and not by the Chief of the Weather Bureau, Mr. W. R. Gregg. The latter recently returned from a national conference of meteorologists in Europe at which little hope was expressed that weather cycles would prove useful in forecasting. It was the consensus of opinion that such cycles exist, but that they are not regular enough to be useful. This is a very poor excuse for the pessimism as to cycles so prevalent among governmental meteorologists. They admit the existence of cycles, but, failing to understand their idiocyncrasies, they give up in despair!

Our Weather Bureau has been notoriously apathetic toward cycle research. It has never conducted any tree-ring or annually laminated-silt (varve) measurements. The writer has never seen any publication of such measurements in its magazine, The Monthly Weather Review. Man-kept records cover such a brief time that the only hope of solving problems involving long weather cycles lies in Nature-kept records, yet that hope has been cast aside by the Weather Bureau and left to enterprising individuals like Douglass, Huntington, De Geer and Antevs.

Secretary Wallace not long ago said that if a large private corporation like the A. T. and T. had an important research problem to solve, it would not hesitate to spend a million dollars annually upon it, whereas our government had seemed indisposed to spend even $1,500 annually.

The very fact that cycles are known to exist, but are also known to have been unreliable as aids in forecasting, is reason enough for seeking a better knowledge of them. This means, first of all, to ascertain the average length of every cycle with the greatest attainable accuracy. That obviously involves using tree-rings and annual silt varves covering thousands of years.

The next step must be the testing of every conceivable hypothesis of the causes of cycles, for until the causes are known, cycles are likely to remain of little utility. But right at the very threshold of an investigation of causes, nearly all meteorologists agree that it is not worth while investigating any but thermal, gravitative and inertial causes. Yet no one claims meteorological science to be even reasonably satisfactory. Its goal is forecasting, and its forecasting is the subject of endless jests. Only the other day a celebrated columnist said that at a banquet attended by authors he sat beside the local weather forecaster who is an author of "much light fiction."

Michael Faraday, the most celebrated researcher in electricity and magnetism, advocated a magnetic theory of certain air-currents (Researches, Vol. 3, p. 265) yet not a single meteorological book or article that the writer has read even mentions that theory. Was Faraday such an impractical dreamer as not to be worthy of attention? Or have meteorologists been so completely obsessed with the assumed sufficiency of the convection theory and its affiliates as to lead them to search for no other cause of air movements? Whatever the reason it lacks justification, for a "sine qua non" of successful research of this sort is the study of many different hypotheses—the multiple hypothesis method advocated by Chamberlain and by many other researchers.

The writer, after much study of the subject, believes that climatic and weather cycles are due to periodic changes in the number of solar electrons that enter the earth's atmosphere. He believes that the periodicity is due to the gyrations of the axes of electron-shells that encase both sun and earth, as well as to periodic changes in the direction of the axes of sun and earth toward one another. The latter, for example, should cause a climatic cycle of about 26,000 years, and Bradley has fully established the existence of a cycle of that order of length in the oil-shales and marls of Colorado. Bradley measured only a few hundred of those varves. Let the government measure several thousand—26,000 if possible—and the cause of that cycle will undoubtedly be found by finding its length. Ascertain, beyond doubt, the causes of one cycle, and the causes of others will probably be found to be similar. Since the sun's axis doubtless gyrates (perhaps in about 1,000,000 years), a cycle of a few hundred years longer than the gyratory period of the earth's axis probably exists. It certainly exists if the solar electronic hypothesis is sound.

Dr. Ellsworth Huntington of Yale was the first (1922) to advocate a solar-electron hypothesis of weather cycles. Dr. Benjamin Boss, the astronomer, later (1930) adopted it with some modifications. The writer has also adopted it and has added the hypothesis of gyrating electron-shells to account both for sunspot and weather cycles.

Dr. George Ellery Hale has established that the sun is charged with electrons. We know that electrons are constantly emitted from the earth; hence strong analogy supports the belief that they are emitted from the sun. We know that sunspots, aurorae and magnetic storms are correlated. We know that the earth is encased in several electron-shells. We know that electrons act as nuclei of raindrops. We know that electrons moving in a magnetic field travel spirally around magnetic lines of force. We know that sunspots are rotating vortices. We know that nearly all winds are also rotating vortices.

In short, if one's eyes were not averted from certain facts, it would be impossible to ignore so completely an electronic hypothesis of weather cycles as to refuse to investigate it most thoroughly.

Fig. 1—A Boiler Tube That Failed After 90 Days' Service on a Water With But One-Half Grain of Hardness by Soap Test

SCALE AND CORROSION CONTROL IN AQUEOUS SYSTEMS

By DAVID W. HAERING*
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Chicago, Illinois

ALTHOUGH the subject of scale and corrosion control has been receiving considerable attention the past few years, the problem remains a serious one for the industrial water consumer. While the municipal water works have been making great strides in supplying improved water for domestic purposes, the average industrial organization must employ additional processing methods for such ordinary applications as hot water and boiler feed water. Scientific attention to these water processing problems has developed additional data and more efficient methods for the solution of such problems. However, conditions in many industrial plants are sufficient evidence that the problem is far from solved and when more complete solutions are available, continued effort to evolve more economical methods may be expected.

Scale formation may be regarded as crystallization from supersaturated solutions at heat transfer surfaces. The formation of an adherent precipitate in this manner is easily understood. The development of supersaturated solutions logically occurs due to normal concentration of the boiler water and due to the inverse solubility curves of scale forming substances. Figure 6 shows the average solubility of such substances. The objectionable features of scale formation require no comment here except to mention that uneven coatings of this sort are frequently responsible for accelerated corrosion (Fig. 7) due to the fact that scale is cathodic to the metals employed in boiler construction and water piping.

*President, D. W. Haering & Company, Consulting Engineers.

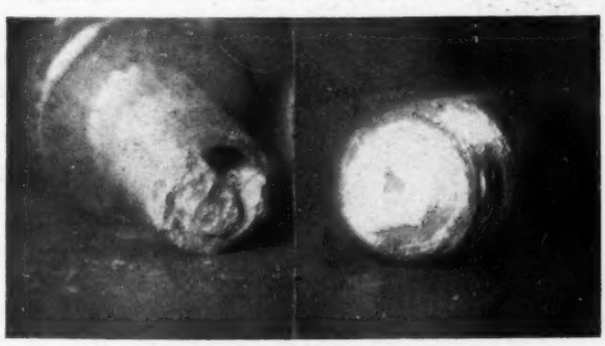

Fig. 2—(Left) Scale Formation on a Steam Line; Cause: Improperly Applied Feed Water Treatment. (Right) A Section of Pipe Taken From a Hot Water System in Chicago After 11 Months of Treatment With Silicate of Soda

Scale Prevention by Internal Treatments

Scale prevention may be accomplished by completely removing objectionable salts before using the water. In practice, this is seldom accomplished by the usual types of mechanical equipment employed and in many plants is not a practical method for economic reasons. The prevention of scale formation by internal methods depends on maintaining all of the elements in the water as soluble constituents or by causing the formation of non-adherent precipitates which may be removed as sludge. The first method may be employed in hot water systems while the second is usually employed in boiler waters.

Of the inorganic materials, the phosphates, aluminates and carbonates are widely used, whereas, the popular sodium carbonate is definitely losing favor. These materials frequently cause feed line deposition, if fed continuously, and the use of organic chemicals of a glucosidal structure to prevent such deposition is fairly common. Many of the inorganic chemicals are most effective in high alkalinities and cause high soluble concentrations in boiler work due to the fact that they replace the scale forming ions with soluble ions. Such conditions adversely effect the economy of operation and the quality of steam produced.

Colloidally dispersed, inert materials have practically ceased to be used. Of the colloidally dispersed insoluble materials, colloidal iron is being used but since this ma-

Corrosion Control Test Specimens

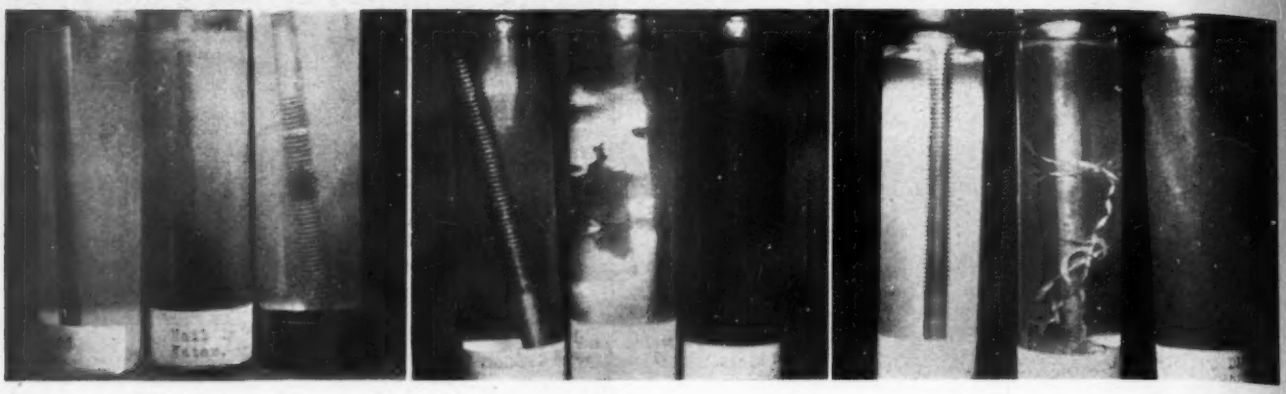

Fig. 3 *Fig. 4* *Fig. 5*

For Indentification and Description Refer to Text. From Left: Exhibits 1 and 4 Represent Water Treated With Organic Inhibitors to Stop Corrosion. Exhibit 5 Represents a Fully Deaerated Water—Otherwise Corrosion as Shown in Exhibit 2

terial probably enters into direct chemical reactions when introduced into water, its reaction is not colloidal although subsequent reactions with iron salts formed may exhibit some colloidal characteristics. Colloidal iron is an interesting development which, in some respects, follows principles originally applied in deactivation equipment. It is not as important a development, possibly, as the application of organic chemicals on a scientific basis.

The Adaptation of Organic Compounds

The organic field has long been a source of water treatment chemicals and, if the potato episode is correct, was probably the original entry of organic compounds into the boiler feed water treatment field. There is little resason to doubt the story as the application of the potato, and subsequently its peeling, is common knowledge. Starch exerts the influence of a protective colloid in water treatment. The use of starch in the present Navy Compound Formula is for the purpose of inhibiting foaming (1) but its application as a protective colloid antedated this adaptation by many years. The formation of soluble calcium salts through conversion to saccharates, through the medium of glucose and molasses, has been widely employed and is still utilized to a small extent.

Tannin yielding materials combined with alkali have been used for years and are being applied today on a wide scale. Sodium tannate is being used less, however, as more efficient organic materials become available. Tannin reacts with iron, to form black iron tannate, and may cause scale formation to be disregarded by the operator due to the black surface presented on casual examination. Tannin may also prove a source of corrosion due to this factor although the formation of a protective tannate coating may inhibit corrosion sufficiently to prevent any difficulty from this source.

The Efficacy of Glucosides

The glucosides and their products are being applied for scale prevention and probably present the greatest inroads on the inorganic field at the present time. These materials react with the heavy metals to form colloidally dispersed gels which complete the scale prevention reaction through absorption. Algin, and its sodium salt, is also used in this way. The glucoside products, such as sodium glucosate, pyro-glucosate and phospho-glucosate, combine many of the advantages of the inorganic and organic chemicals and provide the necessary range of characteristics to cover the requirments of varying water supplies. This has been of the greatest importance in attempting to apply organic chemicals generally.

The application of any chemical treatment requires routine testing supplemented by laboratory examination. The tests carried out and the chemical balance maintained depend largely on the treatment being used. The fact that soap hardness tests have been used for a period of years, and are convenient to make, does not imply that they reveal the quality of information needed to maintain correct conditions. In many cases soap tests for hardness and in fact any hardness test is meaningless. Fig. 1 shows a boiler tube that was removed after ninety The same boiler was subsequently operated at four grain hardness without scale formation
days' operation at a one-half grain soap test hardness.

Control Tests

The most satisfactory method of controlling conditions is to test directly for the chemical being used and adjust schedules accordingly. It is equally important to determine the alkalinity in order to be sure that the most effective range for scale prevention with the particular treatment being used is maintained. Sulphate tests may be important with respect to embrittlement ratios, although this continues to be a controversial subject. Sulphate determinations with respect to scale prevention are often important. Chloride tests indicate soluble concentrations and are also used to indicate scale prevention. In general a complete test is necessary to draw correct conclusions regarding conditions. The fact that relatively high hardness may be carried in the presence of organic chemicals has confused the operator using such treatments. Chloride sulphate ratios and chloride silica ratios are being used successfully for control in such cases. The fact must be emphasized that conclusions drawn from boiler water analyses depend on complete knowledge of the chemical treatment in use. A desirable equilibria with one chemical may be wholly undesirable with another.

In addition to testing for scale control, attention must be paid to corrosive tendencies and to the quality of the steam. Oxygen tests and pH determinations are usually the most effective control tests as far as corrosion is concerned. However, if a chromate is being used to inhibit corrosion, the oxygen test is valueless. In the case of foaming or wet steam conditions the alkalinity range permissible will vary with the treatment used. High hydrate alkalinities definitely encourage foaming tenden-

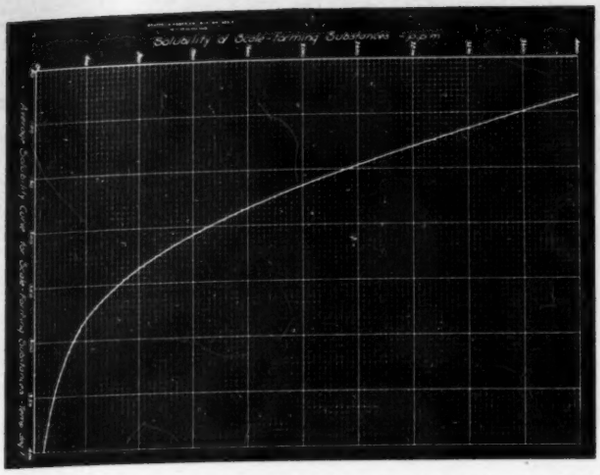

Fig. 6—Decreasing Solubility of Scale Forming Substance With Temperature Increase

cies in all cases. Suspended matter may contribute to the foaming, whereas, a moderate amount of suspended material seems to inhibit the foaming tendency. The quality of steam produced is also important in scale prevention as sufficient solids may deposit in steam lines to cause serious trouble. In Fig. 2 (on left) is pictured a steam line scale formation resulting from an improperly applied feed water treatment. The importance of a good quality steam where steam is used in processing or power generation requires no discussion.

A Word About Silicate of Soda

Sodium silicate has been such a widely used and abused chemical that it warrants mention before going on to a discussion of corrosion. Widely employed as a "boiler metal treatment," sodium silicate is used in a number of boiler plants under a variety of trade names—and, all the colors of the rainbow. The statement that this material forms a film which does not increase in thickness is not confirmed by the writer's experience. Very hard thick scales are formed by its continued use. Since the quantities required to soften the water are based on equivalent reactions, there does not seem to be any merit in the contention that a beneficial reaction on the boiler metal occurs. If oil contamination occurs in the feed water, the use of silicate aggravates a serious condition. In corrosion control the coatings formed are not always impervious and several instances of severe pitting beneath silicate coatings have come to the writer's attention. In Fig. 2 (on right) is pictured a section of a hot water pipe which became seriously scaled after eleven months of sodium silicate treatment in a hot water system in Chicago. This pipe was installed new at the beginning of this period and represents an unusual case. It demonstrates the fact, however, that sodium silicate will continue to form scale after the original coating is formed.

Corrosion Control

The causes of corrosion in aqueous systems may briefly be listed as oxygen, carbon dioxide, pH, nitrates, chlorides and voltaic couples. Oxygen and pH are the most important factors in controlling corrosion rates chemically but physical factors such as pressure, temperature, stress, surface nature and velocity will also influence the corrosion rate directly. Carbon dioxide is an important factor in hot water systems and in steam and return lines. Nitrates and chlorides may cause boiler corrosion by temporary conversion to their respective acids. Voltaic couples due to dissimilar metals are often a cause of severe corrosion but represent construction errors which must be corrected by replacement.

In order to adequately study the subject of corrosion, many total immersion tests representing a variety of conditions and corrective measures have been carried out in our laboratory. Weight loss tests based on polished or thoroughly cleaned sections of metal do not adequately represent plant conditions where rusted, rough and scaled metal is the rule. Consequently our tests have been made on unpolished metal and in some cases mill scale and other deposits have been present. Metal strips have been bent and scratched in order to simulate plant conditions where stress and the use of cleaning tools introduce these factors. The amount of corrosion taking place is judged by the appearance of the solutions and the test sections. This method does not interrupt the test in order to take weights and permits uninterrupted observance of the test over a period of years. In order to adequately record such tests, a filing case containing five boards equipped with clamps to hold twenty specimens was designed. Using this arrangement, one hundred specimens may be filed in a minimum of space and remain immediately available for inspection by simply removing the boards which slide in and out of the case. Such samples have been kept for four years and it is proposed to continue the tests without destroying any of the existing specimens. The accompanying illustrations are unretouched photographs of a few of these tests. It may be mentioned that the data obtained from these tests has checked accurately with practical plant experience and that corrective measures tested in this manner have worked out practically in plant operation.

The application of mechanical methods of corrosion control are generally most effective when combined with chemical treatment. In this discussion, chemical methods only will be considered briefly. For practical purposese these may be divided into two groups: those which remove objectionable factors by direct chemical reaction and those which act as passivators.

Hydrogen ion (pH) control is generally effected by direct reaction and, as values between 9.5 and 10.5 are desirable, alkaline salts are frequently used. Caustic soda, tri-sodium phosphate, di-sodium phosphate, sodium glucosate and sodium phospho-glucosate are used for this purpose. Where the aqueous material is recirculated buffer effects, in order to maintain pH values without change over long periods of operation, are desirable and the phosphates are often used in this manner. Water is difficult to buffer and the organic materials such as the glucosates are most valuable for this purpose.

Oxygen is also controlled by direct chemical reaction using ferrous salts, sulphites and sulphoglucosates. Of these materials sodium sulphite is being extensively used in boiler operation. The sulphoglucosate is being employed in both boiler and hot water systems. Various tannins and other vegetable extracts are also being used for this purpose but it appears probable that their inhibitive effects on the corrosion rate are more frequently due to passivator effects than to quantitative removal of oxygen.

Sodium silicate is often used as a corrosion inhibitor

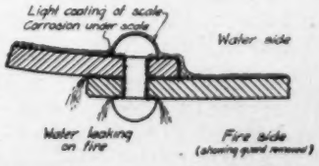

Fig. 7—Leaky Boiler Resulting From Scale Hidden Corrosion (Sketch Made During an Inspection)

because of its coating effect. Frequently the quantity used is based on simple pH control and in this respect its use may be regarded as direct action. As its coating is not evenly distributed throughout the entire system, its use may be objectionable. Fig. 3 contains three test specimens. On left—an organically treated water showing no signs of corrosion. In center—untreated Lake Michigan water showing definite corrosion. On right—a sodium silicate treated water showing the formation of an uneven coating and resultant pitting.

Passivators

Passivators may generally be regarded as materials which produce protective films on the metal surface protecting it from deterioration. With most of these materials, the initial corrosion rate is accelerated but after the film is formed, the corrosion rate drops sharply according to the effectiveness of the passivator. Among the chemicals commonly used as passivators may be mentioned the chromates, silicates, phosphates, chromglucosates, tannates and the amines which will be mentioned later. All of these materials have a limited field of usefulness and require close pH control with the exception of the chrom glucosate which provides good protection over the pH range six to twelve.

The application of various amines as corrosion inhibitors in some fields and the development of the molecular film theory by Dr. Mann (*2*) has a corollary in the water field in the application of various glucoside derivatives as passivators. The efficiency of such a material as chrom glucosate may be due to preservation of the initial oxidation film by the molecular film which would also aid in forming an impervious coating.

Fig. 4 shows an interesting group of samples. On left—a completely treated water using organic chemicals. Center—a specimen of pitting using a boiler water which analyzed an oxygen content and alkalinity suggestive of such action. The pits in this sample have been increasing in size steadily for several months. On right—a tannin treated water in which the dense cloud of black iron tannate obscures the specimen. Corrosion is proceeding in this sample at a slightly lower rate than that experienced with the untreated water. The initial rate of corrosion, however, was much higher.

The successful application of corrective chemical measures to water systems depends on maintaining the desired chemical balance continuously over prolonged periods of time. The industrial field has been slow to adopt sensitive proportioning devices and failure to check laboratory work in the field has been due more often than not to slip shod methods of introducing chemicals. Many plants today are attempting to control corrosion in hot water systems by one shot introductions of chemical with little or no success, whereas, the use of a simple proportionate feeder would produce definite results. The development of adequate after treatments for mechanically treated water has been helpful in educating plant operators to the need of such equipment. However, there can be no doubt that many thousands of dollars per year are wasted in the smaller plants because of failure to use such equipment, the need of which should be obvious.

Voltaic couples as a source of corrosion have been mentioned. There are not generally any chemical means for controlling this reaction and extreme care to avoid such conditions should be exercised when installing new equipment. Deaeration is helpful in reducing corrosion but does not influence the corrosion rate as completely as gas removal by direct chemical reaction. Figure 5 shows some additional test samples. Left—a specimen in deaerated Lake Michigan water showing a slow corrosion rate. Center—deaerated distilled water in which pitting of the specimen has been induced by the introduction of copper. Right—deaerated distilled water showing general corrosion as distinguished from the pitting exhibited in the previous sample.

The chemicals and corrective measures for the treatment of water mentioned in this article are being applied industrially in boilers, hot water systems, brine systems, diesel circulating systems, condenser systems and more recently in calcium chloride anti-freeze solutions. New and more effective methods of control are being developed continually with the field of organic chemistry playing an increasingly important part in the effort to control scale and corrosion efficiently and economically over a wide range of pressure and temperature conditions.

1. "A New Boiler Water Treatment for the U. S. Navy"—T. A. Solberg and R. C. Adams, Jr. "Combustion"; December, 1933.

2. "Organic Inhibitors of Corrosion"—Chas. A. Mann, E. E. Lauer and C. T. Hultin. Jour. Ind. and Eng. Chem.; February, 1936.

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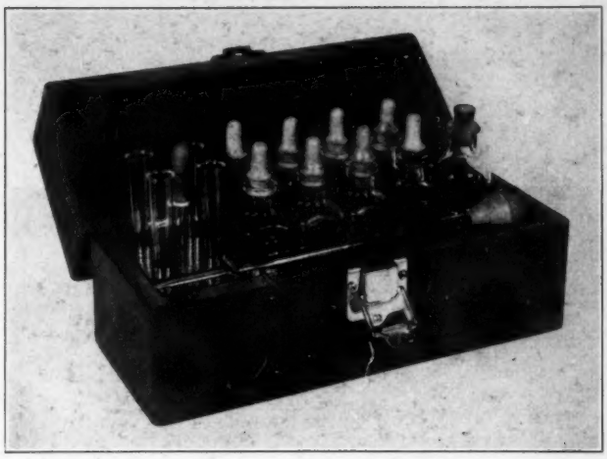
A Prize Root Grown

Roots of poplar tree, found growing through crack in clear well water at Evanston, Ill., filtration plant. Roots grew to a length of 25 feet in a two-year period. H. R.

Frye, chemist in charge of filtration, holding this prize root growth, says that it merely shows the healthfulness of Evansston water, and explains why "babies cry for it."



Complete Test Kit for the Determination of Sulphides

AN IMPROVED METHOD FOR THE DETERMINATION OF SULFIDES

By RICHARD POMEROY

Research Chemist,
Los Angeles County Sanitation Districts,
Los Angeles, California

THE problem of overcoming hydrogen sulfide nuisances, both in the care and disposal of sewage and in the treatment of water from sulfurous sources, is focusing attention on methods for the determination of sulfides. Sanitary and water works engineers have been conscious of the need for a quick, simple field method for determining sulfides, which would be at the same time sensitive and accurate. They have also felt the need for a reliable method with which to distinguish the different forms of sulfide. A research project has been carried out at the laboratory of the Los Angeles County Sanitation Districts involving a study of this subject. The result has been the derivation of considerably improved procedures which eliminate most of the uncertainty involved in the methods previously available. A detailed description of the experiments is being published elsewhere (1). It is hoped that this article, in presenting the method and practical results, will be of greater value to operators and engineers who are not interested in the intricate chemical details set forth in the paper referred to.

Measurement of Total Sulfides

The methods which have been most commonly used in the United States for determining total sulfides in water and sewage are: the iodine titration methods and colorimetric methods.

In the colorimetric methods the formation of sulfide precipitates of antimony, lead, copper, iron, and cadmium have been made use of.

The modified iodine method, as suggested by the Committee on Methods of Sewage Analysis of the Federation of Sewage Works Associations (2), is sensitive and accurate. However, it is not as practicable, simple, or as quick as may be desired for a field method. The colorimetric methods, depending upon sulfide precipitates, are simple and convenient for qualitative purposes, but when applied to sewage are subject to serious inaccuracies, and especially so in the presence of iron salts. Furthermore, they do not reliably detect sulfides at concentrations below 1 p.p.m.

Of all of the methods investigated in this laboratory, that which has been found most satisfactory for a field test, to determine total sulfides in water and sewage, depends upon a reaction which produces methylene blue. Such a method was first suggested in rudimentary form by Emil Fischer in 1883. The procedure is essentially that of adding an acid and an organic base (para-amino-dimethyl-aniline) to the sample and, thereafter, ferric chloride. In the reactions which result methylene blue is produced from any sulfide which may be present. Almy (3), and others quoted by him, recommended the method. Buswell (4) applied Almy's procedure to sewage analysis. As given by Almy, the test required two hours. Lorant (5) modified the procedure, and stated that his modification gave practically complete color development in ten minutes, but recommended waiting one hour before taking readings.

The research at this laboratory has led to several further modifications, which make it possible to apply the method directly to sewage or water without first removing the sulfide to another solution, and to make a complete test in two or three minutes. The procedure follows:

The Los Angeles Methyline Blue Method

Solutions:

1. Para-amino-dimethyl-anilin hydrochlorid in sulfuric acid. A solution is first prepared containing 20 grams of freshly purified para-amino-dimthyl-anilin in enough concentrated hydrochloric acid to make 100 ml. of solution. Two ml. of this solution are added to a mixture of 50 ml. of concentrated sulfuric acid (c.p.) and 48 ml. of water.
2. Sulfuric acid. A 1:1 mixture of sulfuric acid and water.

3. Ferric chloride. 75 grams of $FeCl_3 : 6H_2O$ in enough water to make 100 ml. of solution.

4. Di-ammonium phosphate. 400 grams of $(NH_4)_2 HPO_4$ in enough water to make one liter of solution.

The above solutions are virtually permanent if kept stoppered.

Procedure:

1. Pipette 7.4 ml. of the sample into a 5/8 in. test tube.
2. Add 0.5 ml. of solution 1.
3. Add two drops of solution 3. Mix the contents by closing the tube with the thumb and inverting slowly once or twice. A blue color indicates the presence of sulfides.
4. Wait for *one minute*. (Extending this interval to several minutes will not affect the result appreciably, but the time should not be reduced below one minute.)
5. Add 1.7 ml. of solution 4 and mix.*

The foregoing basic procedure is valid for sulfide concentrations between 0.1 p.p.m. and 10 p.p.m. For higher concentrations the sample may be diluted.

Color Comparisons:

Two methods are suggested for reading the colors. The first is by use of standard ampules. Standards which can be used for several days may be made with methylene blue, using 5.90 p.p.m. of 100 per cent methylene blue dissolved in pure water for each p.p.m. of sulfide. Permanent standards may be made with copper nitrate solutions, or, better, with mixtures of vanadyl sulfate and cobalt sulfate (1). If the method is applied to sewage or water of high turbidity, a block comparator should be used.

The second, or "drop method," is as follows: Prepare a second tube according to the same procedure as given for the test, except that solution 2 is used in place of solution 1. Prepare methylene blue solutions containing respectively 1.240 gm. and 0.124 gm. of 100 per cent methylene blue per liter, and provide droppers which will deliver just 25 drops of these solutions to make one ml. Drop the methylene blue solutions into the second tube until the color of the first tube is matched. One drop of the stronger methylene blue solution corresponds to 1 p.p.m. of sulfide, and 1 drop of the dilute solution corresponds to 0.1 p.p.m. This "drop method" is particularly suitable for sewage testing—especially so when the sewage contains large amounts of clay.

Advantages of the Method

The outstanding advantages of this method in contrast to the other colorimetric methods are its sensitivity and accuracy. By using larger samples, sulfide concentrations down 0.01 p.p.m. can be measured. This is of importance in the problems of water supply, because sulfide concentrations of even less than 0.1 p.p.m. may impart pronounced tastes to the water. In water or clarified sewage the accuracy of the method is limited only by the skill of the user in matching the colors. By using a refined colorimeter, Lorant (5) obtained results with an average error of 2 per cent. In applying the method in this laboratory in the manner in which it would be used in ordinary field work, the average error with pure solutions was 6 per cent. When applied to raw sewage the error was somewhat greater, with a tendency for the results to be low if the sulfide concentrations are above 3 p.p.m. But even under the most adverse conditions the method is far more accurate than the other colorimetric methods. It is not subject to interference by any substances ordinarily present in sewage. In rare cases involving sewages containing large amounts of sulfites or other equally active reducing agents, the method will produce erroneous results.

Here illustrated is a commercial set which has been designed to make this method generally available. Another set, also on the market, has the added features of a block comparator and permanent standards.

*The original procedure called for 2 ml. of solution 4. Use of 1.7 ml. has been found satisfactory, and avoids the occasional formation of a permanent precipitate of ferric phosphate due to slight inaccuracies in the strength of solutions, or in following the directions.

Forms of Sulfides

The methylene blue procedure provides a very suitable method for determining the total inorganic sulfide content of water or sewage. Another problem which must be considered is that of distinguishing the different forms of inorganic sulfides. For practical purposes three forms should be considered—insoluble sulfides, dissolved hydrogen sulfide, and dissolved sulfides other than hydrogen sulfide. Water devoid of suspended matter obviously contains no insoluble sulfides. Ordinary septic sewage will have a few tenths of a part per million of insoluble sulfides, or much larger amounts if iron salts have been added. The easiest way to separate the insoluble sulfides is to add a little aluminum sulfate and an equivalent amount of sodium hydroxide, flocculate and settle. The clear liquor may be used to determine the total dissolved sulfides. In these operations, as in all others in the determination of sulfides, care must be taken to avoid aeration of the sample.

The engineer in most cases would like to know the total amount of hydrogen sulfide which can escape from a sample of water or sewage, and to know the rate at which it will escape. The determination of the total dissolved sulfides, that is, the sulfide determination after removal of suspended matter, measures the amount of H_2S which ultimately can be removed by thorough aeration. At any given time only a fraction of the dissolved sulfides are in the form of H_2S, but if one starts to remove this H_2S more of the other soluble sulfides hydrolyze to H_2S until no more of the non-volatile sulfide remains. The concentration of free H_2S in solution, or the fraction of the dissolved sulfides which are in the form of H_2S, determines the relative rate at which H_2S can escape from the solution. This rate of escape is of great importance, especially in the field of sewage chemistry, for ordinarily in a sewer only a small fraction of the sulfides present escape into the atmosphere above the sewage. In this case the rate of escape is of much more importance than the *total* amount of H_2S potentially available.

Volatile vs. Non-Volatile Sulfides

The fraction of the dissolved sulfides in the form of H_2S is determined by the pH. Table I gives the fractions at various pH values.

TABLE I

pH	Percent of Dissolved Sulfides in the Form of:	
	H_2S	Other Sulfides
5.0	99	1
6.0	92	8
6.6	73	27
7.0	52	48
7.4	31	69
8.0	10	90
9.0	1	99

The table shows that at a pH of 7.0 about half of the dissolved sulfide is present in the form of hydrogen sulfide—H_2S. From a solution of this pH value H_2S can

escape about half as fast as from an acid solution of the same total dissolved sulfide concentration, for in the acid solution all of the dissolved sulfide would be present as H_2S. At a pH of 8.0 the rate of escape would be only 10 per cent as fast as in an acid solution, and at pH 9.0 the amount escaping will be negligible under most conditions.

These figures of rate of escape are of course relative. The absolute rate of escape in a given situation is not easily determined, but experience at this plant indicates that odors are noticeable when the concentration of *hydrogen sulfide* in the sewage exceeds 0.5 p.p.m. Deterioration of concrete and ironwork apparently begins to be serious at about the same point, but copper alloys and lead paints are darkened when in the neighborhood of sewage containing even 0.1 p.p.m. of hydrogen sulfide.

It is to be hoped that further use of improved methods of testing will provide more reliable information as to the limits below which the sulfide concentrations must be held in order to avoid odors and corrosion.

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1. To be published in an early issue of Sewage Works Journal.
2. Sewage Works Journal, **7**, 483 (1935).
3. Almy, Jour. Am. Chem. Soc., **47**, 1381 (1925).
4. Elder and Buswell, Jour. Ind. & Eng. Chem., 21, 560 (1929).
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Eighth Edition of "Standard Methods" Incorporates Many Improvements

A Review by Harry A. Faber

REVISED and published under the joint sponsorship of the American Public Health Association and the American Water Works Association, the Eighth Edition of "Standard Methods for the Examination of Water and Sewage" must be regarded as a noteworthy accomplishment. A joint editorial committee with Harry E. Jordan as chairman, has carried out the major portion of the work of preparation of the new edition.

While size alone can be no criterion, the 309 pages of the present volume compared with the 180 pages of the seventh edition indicate the inclusion of much additional and needed material. Amongst new material is to be found the "Provisional Standard Methods of Sewage Analysis," now considered as "Standard" in this edition. These methods were published in the "Sewage Works Journal" for May, 1935, by a committee of the Federation of Sewage Works Associations under the chairmanship of W. D. Hatfield. This volume includes for the first time, then, methods for the examination of sewages, industrial wastes, and sludges such as have been approved by the Sewage Works Association.

The committee has found it desirable to make certain changes in the order of procedures so as to make methods more readily available to those interested in certain specific places of water analysis. Part I now includes those methods most frequently used in sanitary examinations, and the second part those more applicable to mineral determinations. The sections on turbidity, odor, and chloride have been rewritten, while new methods for the determination of boron, copper, iodide, phosphate, potassium, silica, and other materials have been added while the procedure given in the seventh edition was generally satisfactory for municipal softening plant control, and for locomotive boiler water supplies, they were not desirable for the control of stationary boiler waters. The more exact analytical methols required for this class of work are included in this edition. Under the chairmanship of S. T. Powell these have been prepared by "The Joint Committee on Boiler Feed Water Studies." The new section on mineral examination of waters now includes seventy pages.

In view of the publication, during the last few years, of simplified procedures for the bacteriological examination of water, the confirmatory method for the coli-aerogenes group has been modified. The use of liquid media is now permitted as a substitute for the solid media. Presumptive, confirmed, and completed tests are now the standard terms to be applied. Several pages are devoted to a discussion of the estimation of coli-aerogenes group density employing the "most probable number" method. Microscopical methods have been revised, the section considerably enlarged and additional methods included, particularly by the addition of the centrifuge method for concentration.

A number of procedures have been largely revised with reference to considerable data recently made available. As an example of such changes, the important standard procedure for resident chlorine determination by the orthotolidine method has been modified very materially. It now includes as many means of eliminating interfering substances as have proven practicable, but these are properly listed in the appendix to eliminate confusion in carrying out the "Standard" procedure. The specifications for the colorimetric comparison tubes are now precisely stated under a special heading in the text. A provisional method for chloramine determination is also given in the appendix.

The adoption of an appendix to include provisional or non-standard methods was sufficiently successful in the previous edition to warrant its continuance in this. Since insufficient study has been given them, some of the provisional methods of the last edition are continued in the same category in the eighth. Others have been sufficiently tried to warrant classifying them now as "Standard" procedures. Additions to the appendix in this edition include a method for the determination of soluble aluminum compounds, lead, dissolved oxygen, and the B. O. D. of chlorinated sewages. The provisional report of the committee on the Examination of Swimming Pool Waters is included in the appendix. Other new material such as staining procedures, buffer standards, and excerpts from the British "Standard Methods" is added for the first time.

Many other improvements such as the simplification of the cross reference system previously used, will immediately be apparent. The editorial committee is to be highly commended for the size and importance of this work so successfully carried to completion. Not only has the field of usefulness of "Standard Methods" been widened, but everyone using it will find the eighth edition an accomplishment of definite merit.

[Copies of the EIGHTH EDITION of Standard Methods may be purchased through the American Water Works Association or direct from the American Public Health Association.—Ed.]

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THE SUPREME COURT OF OKLAHOMA has held that a city is liable to the riparian owner who has suffered damage as a result of improper deposit by a city of sewage in a stream. The city cannot avoid liability on the ground that disposal of sewage constitutes a governmental function. Oklahoma City vs. Tyetenicz. Oklahoma Supreme Court No. 25845, December 10, 1935.

PROCEEDINGS OF THE PURIFICATION DIVISION OF A.W.W.A. LOS ANGELES, CALIF., JUNE 8-12, 1936

Reported by J. M. POTTER*

TESTS for activated carbon, boron, fluorine; the control of plankton and insect larvae, corrosion, mixing, coagulation and filtration; and the removal of iron and manganese were the principal topics discussed by the Water Purification Division during the Los Angeles Convention of A.W.W.A. In spite of such magnetic attractions as the main session papers, ideal California

Carl J. Lauter, Washington, D. C., Division Chairman

A. E. Berry, Toronto, Canada, Retiring Chairman

golf weather, nearby bathing beaches, and Hollywood, the informative sessions of the Purification Division were well attended.

In the absence of Chairman Albert E. Berry, of Toronto, Ontario, the meetings were presided over by Vice-Chairman Carl J. Lauter of Washington, D. C.

The following officers were named for the coming year:
Carl J. Lauter, Washington, D. C., Chairman.
W. C. Lawrence, Cleveland, Ohio, Vice-Chairman.
C. R. Cox, Albany, N. Y., Secretary.

Committee Reports and Papers

"Review of Report of Sub-Committee on Specifications and Tests for Activated Carbons," by Mathew M. Braidech, (Chairman), Senior Chemist, Baldwin Filtration Plant, Cleveland, Ohio.

Mr. Braidech reviewed the preliminary 1935 report and summarized the semifinal 1936 report. The latter is a complete 80 page monograph covering the manufacture, physical and chemical characteristics, uses, manner of purchase, packing and shipping, sampling, testing, and the reporting of results. It also includes discussions on pH, fineness, dispersion, and suspensibility with several graphs and tabulated data sheets. A copy of it will be highly valuable to every chemist who purchases and tests activated carbons.

The report contains the following recommendations:

1. That the appraisal of powdered activated carbons for water purification be limited to the phenol absorption test plus the determination of moisture, fineness, and density.
2. That either the Baylis-Gibbs Indophenol or the Fox and Gauge Azo-dye test be used for determination of residual phenol.
3. The use of a "standard sample" as a means of checking analyses.
4. That the Threshold Odor Test be given wider adoption.
5. That the adjustment of price of carbons be made on a premium-penalty basis.

In the discussion Mr. Howard of Toronto inquired what steps would be necessary to require carbon manufacturers to sell on a premium-penalty basis. Messrs. Braidech, Stuart and Jordan believe that most manufacturers would assent to this basis. Those who refused could probably be induced if their bids were not otherwise considered.

"Methods of Testing and Significance of Boron in Water Supplies," by Ray L. Derby, Assistant Sanitary Engineer, Bureau of Water Supply, Los Angeles, Calif.

Mr. Derby's paper was both interesting and informative since it dealt with a constituent which is often present in water supplies but which is rarely considered or estimated. He pointed out that boron had little significance in potable water supplies (thirty parts per million being considered permissible) but was of considerable import in irrigating waters. From 0.1 to 9 parts per million boron may be found in western waters and as high as 28 parts per million are found in hot springs. The average content in the Colorado River is 0.15 parts per million and in the Los Angeles supply from 0.6 to 0.8 parts per million. Limiting quantities vary from 0.5 parts per million for lemon trees to 5 parts per million for olives and cereals, and 100 parts per million for date palms. Removal of boron by chemical treatment

William C. Lawrence, Cleveland, O., Vice Chairman of Division

M. M. Braidech, Cleveland, O., Chairman, Committee on Carbon

methods has not been practical. Los Angeles expected to reduce the boron content of its supply below 0.5 parts per million during the irrigation season by by-passing sources of supply which contained excessive quantities. Mr. Derby recommended the Wilcox method as the most rapid and accurate for the determination of boron.

"Methods of Testing and Significance of Fluorides in Water Supplies," by Joseph M. Sanchis, Chief Chemist and Bacteriologist, Bureau of Water Supply, Los Angeles, Calif.

*Engineer, Technical Service Dept., Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

Mr. Sanchis stated that for more than 15 years substances in water were suspected of causing mottled enamel, but it was not until recently that conclusive evidence attributed the trouble to fluorides. One part per million fluorine was now advocated as the safe upper limit for potable water supplies. Although further investigations are necessary for confirmation, it is generally believed that fluorine entering the body through the natural foods is not significant. Of the various methods of quantitatively measuring fluoride concentration in waters, the colorimetric method seems best adapted. The author's modification of the de Boer procedure, using zirconium-alizarin mixture, indicated that fluorides, sulphates, bicarbonates, sodium, calcium, and magnesium up to 500 parts per million; manganese up to 200 parts; silicates up to 50 parts; phosphates, boron, copper, and iron up to 5 parts; sulphides up to 2 parts, and aluminum up to 0.5 parts per million do not interfere. In the Sanchis modification one half the amount of hydrochloric acid added to the unknown and standards is substituted with an equivalent amount of sulphuric acid. When substances exceed the limits noted, the author recommends isolating the fluorine as hydrofluosilicic acid.

In the discussion H. E. Jordan referred to the increasing number of investigations being made to determine the significance of fluorine and best methods of analyses and its removal from water. He felt that those sections which are influenced by the presence of fluorine should form a central organization to foster, harmonize and report the various researches.

"Plankton and Insect Larvae Control in California Waters," by Gerald E. Arnold, Water Purification Engineer, San Francisco Water Department, Millbrae Calif.

Although Mr. Arnold limited his remarks to California conditions, his suggested methods of control should be universally effective. He pointed out that plankton had been best controlled by the application of chlorine or copper sulphate. Chlorine was more difficult to apply and was effective for short periods only. The use of ammonia in conjunction with chlorine had been the cause of increased rates of growth after the residual chlorine had disappeared. Applications of copper sulphate by means of bags, pumps, sprays or especially designed scattering apparatus were quite successful. He described the San Francisco method of using a boat equipped with a centrifugal pump and ejector which takes in the pulverized copper sulphate and distributes it over an area 50 feet wide by jetting from manifolds along the sides of the boat.

Red worms, which develop from larvae to flies in five weeks, were quite objectionable, especially when they emerged from consumers water fixtures. Practical doses of chlorine and copper sulphate had been ineffective. The only practical method of control was that of covering the reservoirs with insect proof roof. In mosquito control the standard methods were recommended.

In the discussion Mr. Howard of Toronto stated that he believed the joint use of copper, ammonia, and chlorine or cupric-chloramine should be given more attention as it had been reported as being effectively employed in England.

For small ponds or pools, Mr. Enslow recommended a novel means of applying copper sulphate, especially to the shallow areas A bag of sulphate attached at the center of an inflated inner tube could be easily manipulated from the shore line, or a boat with banboo fishing poles, or a drag line.

Iron and Manganese Removal

"Iron and Manganese Removal by Zeolites and Manganese Zeolite Processes," by Eskel Nordell, Chemist, The Permutit Co., New York, N. Y.

In the absence of Mr. Nordell, his paper was presented by Mr. Hugh A. Hannett of the same company. The paper pointed out that standard gravity or pressure zeolite filters were satisfactory for removing iron and manganese along with the softening operation. Whereas, either the "over run" or "bypass" methods could be employed for securing any degree of hardness, the "over run" method removes practically all the iron and manganese. It was to be preferred, therefore, when iron or manganese removal is the problem.

A special manganese zeolite, which has no softening properties, is also used for removing these elements. This type of zeolite is regenerated with sodium permanganate and under average conditions about 1/100 pound per 1000 gallons of water treated will be required for regeneration.

When questioned regarding the clogging effects of iron and manganese on softening zeolites and the concentrations they would remove effectively, Mr. Hannett replied that 10 parts per million iron and 2 parts per million manganese could be removed during the softening operation without serious injury to the zeolite, provided the bed was carefully and completely backwashed before each regeneration.

"The Use of Beds of Manganese Ore in Iron and Manganese Removal," by William G. Kirchoffer, Consulting Engineer, Madison, Wisc.

Mr. Kirchoffer divides iron and manganese bearing waters into three classes: (1) Those which begin to precipitate iron and manganese on exposure to air; (2) those which hold iron and manganese in solution indefinitely, even when aerated; (3) those which contain combinations of the above.

In the latter two types of waters, part or all of the iron and manganese are usually combined with organic acids and are extremely difficult to remove. Under such conditions, a contact bed of catalytic material such

Prof. W. F. Langlier, Univ. of California, Berkeley, Calif.

Sheppard T. Powell, Chemical Engr., Baltimore, Md.

as pyrolusite (manganese dioxide rock) is a valuable item in removing the colloidal iron and manganese. Old filter sand, which had become coated with the higher oxides of manganese, possessed this same catalytic effect. The author told of tests in which manganese dioxide rock was placed in aerator trays. It performed satisfactorily for a while but eventually clogged. He also attempted to use the finely crushed ore in a standard filter, but the weight of the material prevented

effective backwashing. He concluded that a zeolite, or possibly, anthracite coal coated with manganese dioxide was the choice material for removing organic bound iron and manganese.

Prepared discussions by Messrs. Carl Zapffe, Manager of Iron Ore Properties, Northern Pacific Railroad Co., Brainard, Minn.; M. J. Shoemaker, Chemical Engineer, C. F. Burgess Laboratory, Inc., Madison, Wis.; A. S. Behrman, Chemical Director, International Filter Co., Chicago, Ill., were read by Secretary Cox in the absence of the authors. In the discussion it was pointed out that manganese dioxide was the catalyzing agent in

Kenneth W. Brown, Chemist, Calif. Water Serv. Co., Stockton, Calif.

Gerald E. Arnold, Water Purification Engr., San Francisco, Calif.

all compounds whether natural or artificial. For satisfactory operation the water to be treated should have a pH of 6.5 or more and should contain dissolved oxygen.

[We wonder that someone failed to point out the value of heavy chlorination for breaking into organically bound iron complexes and rendering iron precipitation more effective, whether on contact surfaces or otherwise.—Editor.]

"Analytical Control in Anti-Corrosion Water Treatment," by Wilfred F. Langelier, Associate Professor of Sanitary Engineering, University of California, Berkeley, Calif.

Professor Langelier presented a profoundly scientific discussion of a new method which he offers for use in plant control of anti-corrosion water treatment. He derived an equation for arriving at the value pH_s, which is the pH of a particular water when it is in equilibrium with (will neither dissolve or deposit) solid calcium carbonate. In the pH range 7.0 to 9.5 the equation reads $pH_s = (pK_2' - pK_s') + pCa^{++} + pAK$. Here, pK_2' is the negative logarithm of the second dissociation for carbonic acid and pK_s is the negative logarithm of the activity product of calcium carbonate.

pCa^{++} and pAK (alkalinity) are negative logarithms of the molal and equivalent concentrations of calcium and titratable base, respectively. The value of $pK_2' - pK_s'$) varies with salinity and temperature. For soft water at 15 deg. C., it is 2.3 and at 60 deg. C. is 1.5. The difference between the actual pH and pH_s Prof. Langlier designates the "Saturation Index," and its algebraic value determines whether a given water will dissolve or deposit a calcium carbonate film. Professor Langelier stated that experiments with a wide variety of waters at 20 deg. C. confirmed the validity of the equation. Temperature must be considered, since it affects both the pH value and the solubility of calcium carbonate. For instance, the pH of a neutral water at 20 deg. C. is 7.0, while at the boiling point it is about 6.5 and, therefore, a water saturated with calcium carbonate at 15 deg. C. will be supersaturated at 60 deg. C.

In the ensuing discussion Dr. Hale (New York City) and others took exception to the author's statement that CO_2 determination by titration and the contact Marble Test were not reliable methods of control. Sheppard Powell (Baltimore, Md.) told how one large industry had eliminated corrosion difficulties by deaerating the water under a vacuum and by removing the last trace of oxygen with the addition of small quantities of sodium sulphite.

[It is probably unfair to Professor Langelier to attempt a digest of so profound and intricate a paper as was his. Its proper evaluation must await its publication in the Journal.—Ed.]

Symposium on Filtration

"Mixing," by Carl M. Hoskinson, Chief Engineer, Filtration, Sacramento, Calif.

Mr. Hoskinson traced the history of mechanical mixing from the early experiments of Langelier and Hyde at Sacramento to the more recent Flocculator developments by Smith at Richmond, Va. He could not recommend baffled mixing chambers because they were costly, inflexible, and productive of high head losses. Tangential mixing chambers were likewise costly and inflexible. He stated there were insufficient data on the use of compressed air for mixing to warrant definite conclusions. A rapid mix, during which a colloidal floc formed practically instantaneously, followed by a gradually decreased whirling motion, was now considered ideal for most conditions. He described the very successful mixing arrangement at Sacramento, consisting of four tanks with mechanical paddles operated in series. The first tank was operated at 2½ r.p.m., the rate being gradually decreased to 1 r.p.m. in the final tank.

In the discussion, attention was directed to the difficulties caused by large and loosely knit floc and on the inclusion of air bubbles in floc produced in water supersaturated with air. Likewise, the deleterious effect of air leaking into centrifugal pumps.

"Coagulation," by Kenneth W. Brown, Sanitary Engineer, California Water Service Co., Stockton, Calif.

Mr. Brown presented an A to Z paper on coagulation. He discussed coagulation from the initial floc formation, through the entrainment of bacteria and turbidity to the final settling. He reviewed the properties of the various commercial coagulants, including filter alum, ammonia alum, sodium aluminate, copperas, chlorinated copperas, liquid, crystal and anhydrous ferric chloride, and ferric sulphate. He discussed dry and solution feeders and factors to be considered in purchasing such equipment. The requisites for ideal settling basins, according to the author, should include 4 to 6 hours retention, 12 to 15 feet in depth, parallel operation, uniform entrance and discharge rates, 1 foot per minute maximum velocity, and arrangements for rapid effective cleaning. He stressed the importance of laboratory control in connection with good coagulation and thought that minimum control should consist of daily analysis of the raw and filtered water and coagulation jar tests with every change in quality. Mr. Brown's paper apparently had all the answers correct, for there were no questions asked, no arguments raised, or additional information volunteered.

"Filter Design as Related to Operation," by Harry N. Jenks, Consulting Engineer, Berkeley, Calif.

Mr. Jenks stated that while the filter was originally considered the nucleus of a water purification plant, yet it was often merely a polisher and was being called upon to do less and less work due to the rapid progress being made in conditioning the applied water. He expressed the belief, however, that the trend was now in the opposite direction and that new designs should and would place more work upon the filter. He thought this was true because of the recent advances made in pipe and operating gallery design and more especially in the underdrain systems and introduction of surface wash devices. Most standard underdrain systems were satisfactory but he felt that porous plate bottoms without the gravel layer would eventually replace the present designs. The author also commented on the success with which roughing filters were used preparatory to slow sand filtration in England and suggested that this procedure should be more generally considered in this country.

In the ensuing discussion, two schools of thought were heard from. One believed that most filter difficulties were caused by poor preparation of the applied water and that the remedy should be by means of better mixing, coagulation, and settling. The other school agreed with the author that the filter design should be improved and strengthened to the point where it would bear more of the load and earn its keep—so to speak.

Mr. Pierce (Racine, Wisc.) told how the Baylis surface-wash system had done much to eliminate Racine's filter difficulties, and Mr. Schaut (Philadelphia) mentioned that roughing filters had been in service there for a number of years.

"Filtration Without Preliminary Coagulation," by Joseph D. DeCosta, Sanitary Engineer, East Bay Municipal Utility District, Oakland, Calif.

Mr. DeCosta described a unique plant recently placed in service for the East Bay District. It consisted of a three and one-half million gallon rapid sand filtration plant of standard design without means of coagulation. The raw water, taken from an impounded supply, averaged less than 3 p.p.m. turbidity and contained about 0.15 p.p.m. iron. When aerated, a ferric floc was formed which materially aided in obtaining excellent clarification. This plant had been operating at 50 per cent above the standard filtration rate, and with excellent results. The design was such that mixing and settling basins could be added should they be found necessary or desirable.

"The Maintenance of Filtration Plant Equipment," by John Perhab, Superintendent of Water Purification, Beverly Hills, Calif.

Mr. Perhab emphasized the fact that only a small part of filtration plant equipment was in duplicate, and that a faulty gauge or valve might nullify records or completely paralyze operation. Regular inspection, proper lubrication, and external protection paid big dividends by prolonging the life of the equipment and by insuring constant service. Some specific recommendations were: Keep electrical equipment protected from dust and moisture. Keep motors and feeders in proper alignment and lubricate frequently. Keep joints absolutely tight on all chlorine and ammonia equipment. Discard all used gaskets; and never clean metal parts of a chlorinator with water—use carbon tetrachloride. Carbonating (CO_2) equipment requires special attention and should be completely overhauled once each year. Keep the moving parts of recorders and meters free with a light oil and flush control pipes occasionally. Keep pumps packed and lubricated as recommended by the manufacturers. Keep the exposed surfaces of all equipment well protected with a good quality of paint.

Committee Reports and Discussion

Sub-Committee 5-I-D, Standards of Water Quality, by Harry E. Jordan (Chairman), Chemical Engineer, Indianapolis Water Co., Indianapolis, Ind.

Mr. Jordan explained that it would be impossible to formulate a single set of standards of water quality that would be satisfactory for drinking purposes, on one hand, and for all industrial uses on the other. He stated that Professor Gordon Fair and his assistants were making a thorough study of available data on the physiological effects of various substances found in water. An open forum meeting and a "free for all" discussion followed. It was the consensus of opinion that a detailed study should be made regarding the quality of water desirable for various industrial as well as potable supplies. A review of the physical and chemical characteristics of acceptable water supplies as defined by the Treasury Standards was made. Expressed opinions, by the majority, indicated that changes along the following lines should be made Turbidity decreased from 10 to 15; color—no change; odor—no change; lead—doubtful (insufficient data available); copper—probably increased from 0.2 p.p.m. to 2.0 p.p.m. or more; zinc—doubtful, and could probably be raised materially; sulphate—no change; magnesium—no change; total solids—no change; chlorides—no change; iron—could probably be reduced to 0.1 p.p.m. for filtered supplies; caustic (hydrate) alkalinity—doubtful, 5 p.p.m. should be permitted; carbonates of sodium and potassium—could probably be increased.

There was a difference of opinion regarding the desirability of establishing two sets of standards; namely, one set for filtered and one for unfiltered supplies. The majority present seemed to think there should be but

Prof. Lewis V. Carpenter, New York Univ., Chmn. Comm. on Licensing

Walter A. Peirce, Supt. Water Works, Racine, Wisc.

one set of standards for potable water supplies, regardless of the quality of the original source of the supply or methods of treatment.

Committee on Water Works Short Schools and Licensing of Water Works Employees. Lewis V. Carpenter (Chairman), Professor of Sanitary Engineering, New York University, New York, N. Y.

Professor Carpenter opened the meeting with an invitation for questions and a general and free discussion. The question was raised as to the desirability of State Professional Engineering Boards granting licenses to water works employees as operated in the State of Ohio. The majority believed that boards appointed or

controlled by the State Health Departments would be better qualified to grant licenses and would be less hindered by political interference. A query was made regarding the objections to licensing. Professor Carpenter replied that the chief objections were by operators themselves, who feared that they might not be able to meet the requirements; and, also, by privately owned water companies, fearful that licensing might interfere with complete control over their employees. The chairman said that he felt that requirements should be lowered, if necessary, to promote universal licensing. Thereafter the standards could be raised by education. Mr. Gorman (Chicago) suggested that A. W. W. A. should adopt standard regulations to be submitted to the sectional or state associations without waiting for individual state legislation. Professor Carpenter, however, was emphatic that legislation was necessary to insure protection and tenure of office. He also stated that his committee had collected copies of all acts and regulations pertaining to the licensing of water works employees and that they were available to any one who was interested.

Commenting on the short schools, Professor Carpenter said that some of them failed to furnish an appealing and suitable program for operators. Many of the papers were too highly technical or of the uninteresting statistical type. His committee was sponsoring new schools and assisting those already organized, by helping with the programs, and by suggesting speakers. He admitted that it was difficult to prepare new programs every year that would be interesting and instructive to all types of operators. W. H. Weir (Georgia Department of Health) told how their short-school attendance had increased from 60 to 125 in 4 years. Some attendants at the first school were now assisting with the instruction, which solved somewhat the problem of advancement. Other suggestions were offered to keep the short school definitely a school and minimize entertainment and inspection trips. Further, that such schools should be fostered by the State Departments of Health and considerable care in selecting speakers and instructors should be taken.

[*Note*—Previous reports covering the Los Angeles Convention of AWWA have appeared in the June and July issues of Water Works & Sewerage. Digests of other papers, dealing with water treatment, which were presented before the joint session of the Purification Division, and the general membership, may be found in the July issue.—Ed.]

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Michigan Orders Stream Pollution Stopped

To clear up the pollution of the Saginaw watershed, which has rendered Saginaw's public water supply unusable for many domestic purposes and which is seriously affecting commercial fishing in Saginaw Bay, the Stream Control Commission of Michigan has ordered oil operators and a chemical plant to provide means of waste disposal effective in eliminating this pollution. The oil operators plan to pump the brine, a waste product of oil production, back into the ground, which method is to be put into effect at once. The chemical plant was ordered to immediately provide temporary measures which will substantially improve conditions and must provide some permanent means of waste disposal which will be satisfactory to the commission.

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THE THIRD WORLD POWER CONFERENCE AND SECOND CONGRESS ON LARGE DAMS had received assurances of participation from 47 nations up to July 30. The meetings will be held at Washington, September 7-12.

Cases of Pipe Lines That Could "Take It"

In the pictures above are shown a welded steel pipe line, originally buried five feet beneath a river bed. Then came the flood waters leaving the pipe (emptied) exposed for a span of 200 feet. It later sagged to the water line during a second freshet, when the current would force it about 2 ft. down stream. Then it would whip out of the water and return to its previous location after each whip. After several hours of this

stretching and snapping back, a floating section of railroad track plus debris floated down and after 45 minutes put an end to the speculation as to how long *this* line could "take it."

In the second case is shown the result of a freak accident to a string of welded pipe which played Jack and Jill on a steep hillside. If the report is accurate,

even with such a twist and buckling as shown the joints held and the pipe was not split. Modern welding has certainly, in these two instances, given an excellent account of itself and only recently it has come to our attention that a dam faced with welded steel plates had the ribs of the weld metal remaining, even after the facing plates had practically corroded away.

CHEMICAL OR BIOLOGICAL?

A Few Remarks as to the New Trends in Sewage Disposal.

By Dr. Hermann Bach*
Berlin, Germany

The Author

THERE is a strikingly interesting situation indeed today in sewage disposal. Seemingly there is developing a revolution in the fundamental views as to the technical measures by which the objectional fluid called "sewage" may become converted to a friendly liquid worth the term "water."

Revolutions may prove to be of different values. Some righteously wipe away indolent or rotten conditions; some others may proceed too far in the removal of seemingly outmoded practices. In consequence there may result some small progress in subjects of secondary importance, whereas the net cost will be a detrimental result in the matter as a whole.

In the art of sewage purification one important revolution already has occurred. This was due to the lifework of men such as *Frankland, Dibdin, Clark, Dunbar, Stoddart, Fowler,* to count but a few names never to be forgotten in our profession. These leaders brought to sanitarians a recognition of the truth—That it is impossible to economically destroy the organic compounds of sewage by chemical processes; that this difficult problem could, in an economical way, be solved with the aid of bacteria only, through dependence on biological processes. The results of this "revolution" ultimately gained an expression in such achievements as the well-known large activated sludge plants, the effluents of which plants frequently surpass in purity the water in the receiving waterbody.

Today one may discern the indication of a second "revolution"—the "chemical—mechanical"—revolution, which tends to abandon the guiding lines that science has pointed out for sewage treatment. Instead, these new revolutionists recommend the return to methods consciously thrown overboard in the first revolution. In proposing a return to the old, and hundredfold as inadequate proved practices, the new revolutionists tell us that the basic reason is that improved technical methods and equipment have come forward.

It should be emphasized: The first mentioned revolution was chiefly a *scientific* one, the second does not trouble about the science. Instead it is supported by some *technical* points of view only. The arguments for the first is: Because it is scientifically assured that only with the help of bacteria can the sewage matter be destroyed, sewage purification should make use of such technical arrangements as are apt to promote the indispensable bacterial action. The second, without investigating whether new or newly improved technical means are scientifically justified, recommends them in the hope, and with a scientifically unfounded conviction, that this new practice will correct the errors in the science of yesterday and today.

Should this second revolution be welcomed and promoted under the circumstances—Or, should the dangers be warned of?

Destruction or Removal of Organics?

The aim of sewage purification is to destroy or remove the polluting matter from the pure water in order to restore, so far as possible, its original purity. The polluting matter of sewage has been built up by biological processes in the human or animal body or in the vegetable kingdom. The albuminoid and similar matter represent molecules of gigantic dimensions when compared with the very simple molecules that inorganic chemistry affords in the shape of the so-called coagulants. While these latter mostly do not exceed as much as 10 atoms, the albuminoid compounds may count hundreds or even thousands of such "bricks" of stuff.

Basically, there appear two ways to get rid of these giant-compounds: to *destroy* them, i.e., to split the giants to pieces; or, to *remove* them, i.e., to take them out of the water undestroyed.

To split the albuminoids to simple compounds which may be further handled in an easy manner requires a vast amount of energy. To secure this energy with the help of chemicals (even strong ones, such as sulfuric or nitric acid, chlorine, bromine, etc), one is forced to make use of high temperatures, high pressures, or both. Such procedures are, in fact, employed in analytical work in order to destroy such matters as albuminoids to a degree, that the nitrogen or sulphur or other constituents entangled in the highly complicated compounds, become released from the muddle and may be obtained as a simple mineral substance suited for the determination. The employment of energies in such drastic forms is, as anybody knows, out of the question in the work of sewage disposal. In the normal conditions of temperature and pressure (combined with the high dilution in water) it proves absolutely impossible by adding even the strongest inorganic chemicals to the sewage to actually destroy the albuminoids and similar high molecular biologically produced complexes. Under actual conditions, and within the short contact time which is available in sewage treatment, added chemicals will just slightly break into the outer skin of the giant-molecules. The comparatively mild chemicals known as "coagulants" leave such molecules untouched in respect to change in composition.

The Action of Bacteria

The tremendous energies necessary for the destruction of albuminoids and other high molecular organics are

*Chief Chemist of the Emschergenossenschaft, Essen, retired.

only available in the living bacteria. These smallest of the earthen creatures are, in view of their microscopical size, the bearers of the most extraordinary powers in the realm of the living. These powers come into appearance first as the extension of the surface of the bacterial bodies. The proportion of the body surface to the body mass of bacteria is more than 100,000 times as great as in the case of the human body. Such vast area of the body surface enables the bacteria to adsorb organic matter from the sewage with extreme rapidity, the rate being essentially a function of the surface extension. Since the diameters of the adsorbed molecules are too large to pass through the tiny membrane which covers the bacteria cell, the bacteria produce those highly effective products, known as enzymes, which split the large molecules to fragments of a size that can enter the cell. The splitting action continues in the cell, further disintegrating the assimilated substance, eventually resulting in production of elementary particles. In the course of this action, these become combined with oxygen or hydrogen, depending upon whether the condition be aerobic or anaerobic.

Aerobic action is the important factor in the unsurpassed work of wet combustion (aeration), in spite of high dilution, normal temperature and pressure.[1] There results a tremendous force in the activation of elements, i.e., in tearing their molecules to atoms in which state they readily combine with other atoms.

Such feats are high above the reach of man made chemicals. Only the chemicals of the bacterial cell, the enzymes and ferments are enabled to produce such astonishing effects. The biologically built up substance can, in practical or a reasonable way, be torn down by biological action only.

The Question of Coagulation

One may ask, however, will it not prove possible to coagulate the albuminoids and other putrescible organic matter, i. e., to change them from the soluble or semisoluble into the insoluble state, by addition of some simple inorganic chemicals with the purpose of the formation of flocs which occlude the said organics. And, in turn, allow them to settle down to the bottom of the tank, thus *removing* these matters in the form of sludge, without destroying them essentially?

There are indeed some few inorganic chemicals, such as some salts of lead, of mercury, of barium (distinguished by a very high molecular weight), which forms with *some* organic matters complex compounds more or less insoluble in water and thus capable of removal by sedimentation or filtration. It may be superfluous to emphasize that it is quite out of the question, however, to employ such expensive and poisonous chemicals, even in a most exceptional case of sewage disposal.

Nonpoisonous chemicals which economically come into question in sewage disposal practice, i. e., essentially compounds of iron, of lime (possibly also of alumina), lack the property to coagulate albuminoid matter at ordinary temperatures. If the albuminoid bodies should form compounds with the named chemicals, these compounds remain watersoluble or as colloidal as they were before the action of the coagulant. This fact has been proved by innumerable experiments, and such proof may be reproduced by trial.

[1]On the other side, compare the efforts required to succeed in a wet combustion chemically. The strongest sulfuric and chromic acid must be boiled with the substance to be oxidized—i.e., destroyed by chemical combustion.

Partial or Passing Adsorption

The reason why it *seems* that salts of iron, milk of lime, etc., coagulate albuminoids, is that the hydroxide flocs formed by the action of such chemicals occlude and drag down the very finely divided *suspended solids* prevailingly of organic substance. Besides, it may adsorb some part only of the colloidal albuminoids, this latter action being a function of the surface extension of the flocs—not to be compared in area with the surface extension of bacteria. The mentioned adsorbtion, however, is of a temporary, or a passing nature, because the flocs and the sludge do not hold fast all of the adsorbed matters. They become released sooner or later and this effect may be observed in the precipitation tank, before the sludge has been drawn out. In the case of sludge filtration these released matters may be found in the filtrates. Only in the case of sludge digestion do the adsorbed organics become *biologically* destroyed. In such case, however, by no means is less bacterial energy required than is true in the case of biological purification of the liquid portion of the sewage. The aerobic action runs smoother, in fact, than the anaerobic.

To Summarize

It may be summarized: The objectionable matter in the sewage can be *destroyed* by bacterial action only. So far as it is suspended in nonsoluted state it may be *removed* mechanically by sedimentation or filtration or both combined, thus forming sludge. The so-called "coagulants" aid this mechanical action by flocculation, increasing the suspended solids removal. In so doing the amount of sludge is increased beyond that which represents organics precipitated from the sewage. The flocculation affects however only *slightly* the soluble or semisoluble albuminoids, etc., by a *partial adsorbtion* which causes a temporary or passing removal of substances which are subsequently released from the sludge.

The Meaning of Chemical Treatment

It is behind that so-called "chemical treatment" may in some cases of sewage disposal be of value as an aid in the preliminary treatment of the liquid. It may be very useful or even necessary in cases of certain industrial waste treatment. In city sewage disposal the advantage of the increased removal of suspended solids, or of a shortened detention time, should be carefully balanced against the disadvantage of increased sludge disposal difficulties and complications in the working and supervision of the plant. But never can the chemical treatment replace the biological purification of sewage, if a complete treatment is necessary.

Not in the employment of chemicals as coagulants, lays the danger to further progress in sewage disposal practice; but, there is an apprehension, already noticed, that the seemingly easy-working chemical-mechanical processes may be capable of displacing the more or less difficult or annoying biological purification processes of the immediate past. Such apprehension may lead to a disregard of achievements by which sewage disposal was lifted from a poor state of *dillettantisme* to the rank of a science. Further, it may result in the retrogressive abandonment of methods, which—it may be true—demand still a great amount of scientific research and technical development. If these be properly cared for, however, they will certainly sooner or later prove victorious because the victory is always Nature's.

So, may the above remarks serve as a "videant consules."

COMMENTS ON CHEMICAL TREATMENT OF SEWAGES

By WESTON GAVETT, C.E.*
New York, N. Y.

The Author

TO the sewage worker who has also had water purification experience the revival of chemical treatment comes like "Old Home Week." The two have much in common. Chemical treatment of sewage has been out of style for some years, but the treatment of water with chemicals has continued. In the treatment of trade waste the use of chemicals has also continued without interruption.

From the fields of water and trade waste treatment there is available for sewage practice improved chemical feeding apparatus, automatic pH control, modern flocculating devices, automatic turbidity indicating records and control, much data on the physical chemistry of coagulation that was unknown when sewage treatment was in its heyday, around 1890, not to mention a greatly increased fund of practical information. Much of this information and experience may be purloined to advantage for the sewage field.

Twenty years ago, the writer was at a rapid sand water filter plant where the turbidity of the raw water fluctuated between low values to several thousands parts per million. The water had a considerable length of travel through the coagulation basin, and a scheme was worked out for the control of coagulant that was simple and effective. It was found that if the turbidity at a point in the basin not far from the inlet was kept below a certain value, the final turbidity entering the filters would be sufficiently low to insure a satisfactory filtered water. These turbidity readings were taken at frequent intervals throughout the day and night and the coagulant carefully adjusted to the effective minimum. The cost of chemical is a large item in the budget when used for water or sewage treatment. It is very easy to waste chemical by crude application and any method or equipment that will provide for the accurate application of just the proper dose, or more effective and economical coagulation will be a good investment. Today there are available automatic pH and turbidity recorders and controls making possible the automatic control of chemicals either from indications in the treated liquid or in a pilot tank through which a portion of the treated liquid is passed.

Improved Chemical Control

At Lakewood, N. J., an automatic feeder is being installed that will vary the rate of application throughout the day. A number of 24-hour tests showed that the variation of chemical demand was quite uniform on different days. The rate of chemical flow will be controlled from a cam on a Telechron clock which will actuate the rate of feed control, mechanism on the feeder. The cam is calibrated in accordance with the chemical demand. Exact synchronization of chemical feed with the rate of sewage flow is obtained by means of a Chronoflo transmitter which starts and stops the chemical feeder through a relay. The Chronoflo sends out current for fractions of a minute that are proportional to the flow. As the chemical feeder operates only when the current is on, the feed is closely proportionate to the sewage flow.

Twenty years ago there was not available the data on the relation between pH and coagulation that there is today. Nevertheless pH adjustment was carried out, and the laboratory control was effected through use of the very valuable bottle or jar test. At one water plant where alum was used, some operator discovered that a little lime would help at times, although there was ample alkalinity in the water to neutralize the amount of alum used. Jar tests were used to show whether or not lime was needed, and also to show whether iron and lime or alum was more effective for a given water. At that time there was no excuse for the use of lime with alum when sufficient alkalinity was present— except that it worked better, which after all is a pretty good reason.

Another question which embarrassed the writer considerably at that time, when called on the carpet, was why such large doses of alum were used with waters of low turbidity compared to those used on highly turbid waters. The best answer was that the low turbidity water required more coagulant, probably because the suspended matter was fine compared to that in more turbid water. Lacking a suitable balance for the determination of suspended matter, an evaluation of the size of the particles was made by running the turbidity of a sample after various periods of sedimentation. From these values, an estimate of the total surface area of the suspended matter was obtained which gave some indication as to why relatively large doses of coagulant were required for low turbidities of fine material.

Still enthused with the idea of the relation of fineness to coagulant dose, the writer continued experiments at another plant in 1917, using artificial separations of various sizes of silica. The results showed that for water, the coefficient of fineness or ration of suspended solids to turbidity, was of little value. For particles less than .003 mm. in diameter it has little meaning, owing to light transmission through or reflection from the particles of this size and smaller.

The Role of Turbidity and Particle Size

In sewage, the coefficient of fineness may be of more value as the bulk of the suspended solids are of larger diameter than found in water. Raw sewage will have a high value which will decrease with settling. Results at Coney Island reported by Rudolfs, Brendlen & Carpenter show coefficients of fineness of 0.75, 0.53 and 0.38 for raw, settled and filtered sewages. Turbidity is a most valuable control tool at a sewage works. Using a candle turbidimeter results are quickly and easily obtained and slight variations indicated. While turbidities are not directly convertible into suspended solids, a close conversion may be made by multiplying the turbidity by the coefficient of fineness for that stage of the treatment. From the figures from Coney Island, the tur-

*Associate—Clyde Potts, Cons. Engr., New York City.

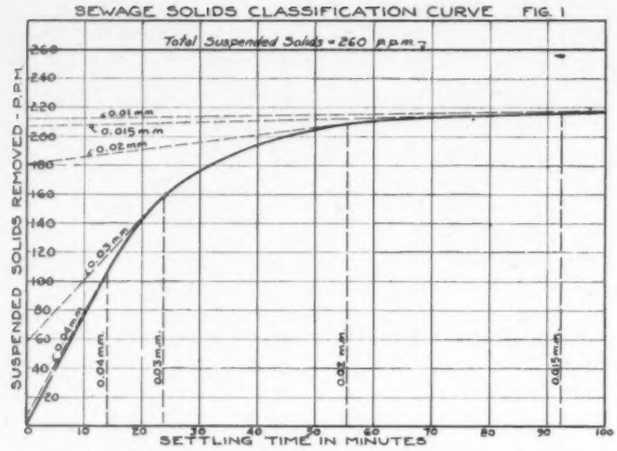

Fig. 1. Curve Showing Effect of Quality of Suspended Solids on Settleability and Clarification.

bidities of the raw, settled and filtered sewage multiplied by 0.75, 0.53 and 0.38 respectively should approximate the amount of suspended solids at that plant. A good rule in running turbidities is to dilute high turbidity samples so the reading on Jackson turbidimeter is between 100 and 200.

An interesting picture of the nature of the suspended solids in a sewage is obtained by plotting the settling curve of a sewage as shown in Figue 1. The solids removed, ordinates, are plotted against time, the abscissa. Also plotted on the abscissa are sizes of particles corresponding to the period of settling. The location of particle sizes is based on the theoretical velocity of sedimentation for particles with specific gracity of 1.1, settling a distance of 10 cm.

Colbeck and Harner (Ind. & Eng. Chem. v. 19, p. 58) describe a method for obtaining the various sizes of particles in pigments from such a curve. Tangents drawn at any point in the curve intercept the verticle axis at a point which gives the amount of material larger than the size at which the tangent is drawn. From these figures a determination of the quantity of material of various sizes and the surface area may be obtained which will give in one figure, a measure of the amount of fine material present.

The calculation of the surface of the suspended matter is determined from the curve as follows:

Size mm.	Suspended solids p.p.m.	surface sq.cm./m.g./	Total surface sq.cm./liter
less than 0.01....	48	8	384
0.01—0.015	5	4.35	22
0.015—0.02	27	3.10	84
0.02—0.03	122	2.18	266
0.03—0.04	53	1.57	83
larger than 0.04..	5	1.3	6
	260		845

(Surface for sp. gr. of 1.1 = 0.0545/d —d in m.m.)

John R. Downes presented a paper before the New Jersey Sewage Works Association in 1933 describing experiment sat Plainfield which showed that proportionate reductions of turbidity and B.O.D. could be produced by doses lower than that required for maximum precipitation. L. Luther in experiments conducted at Freeport, Long Island, in 1932 and 1933, obtained similar results on an entirely different type of sewage, much fresher than that at Plainfield.

Comparing the results on the basis of p.p.m. non-settleable turbidity removed per pound per m.g. of ferric chloride, results at Freeport varied from 0.9 at 40 per cent removal to 0.3 at 80 per cent removal, while Downes showed from 4.0 to 1.8 p.p.m. removed per pound ferric chloride at 40 and 80 per cent removals respectively.

These values are for turbidities. Suspended solids should show a closer agreement, as a plotting of per cent removal of total turbidity against coagulant showed similar curves. A measure of particle surface should be of great interest in connection with coagulant dose.

The Value of Effective Mixing

In a discussion of Mr. Luther's paper on the Freeport experiment at the meeting of the New York Sewage Works Association in October, 1933, the writer mentioned that quite respectable coagulation or aggregation may be obtained with no chemical at all but with proper and effective mixing only. Fifteen to 40 per cent of the turbidity remaining after sedimentation may be removed by slow mixing preceding sedimentation.

[In San Francisco this fact has been demonstrated sufficiently to warrant the adaptation of flocculating equipment to be operated regardless of whether chemicals are used or not.—Ed.]

The necessity for mixing has long been known and the early chemical precipitation plants included mixing basins. To obtain the maximum agglomeration of particles of suspended solids either with or without chemicals, the particles must be jostled *gently* together. An idea of the wide separation of particles may be obtained from the calibration of the Jackson turbidimeter. To

FIG. 2

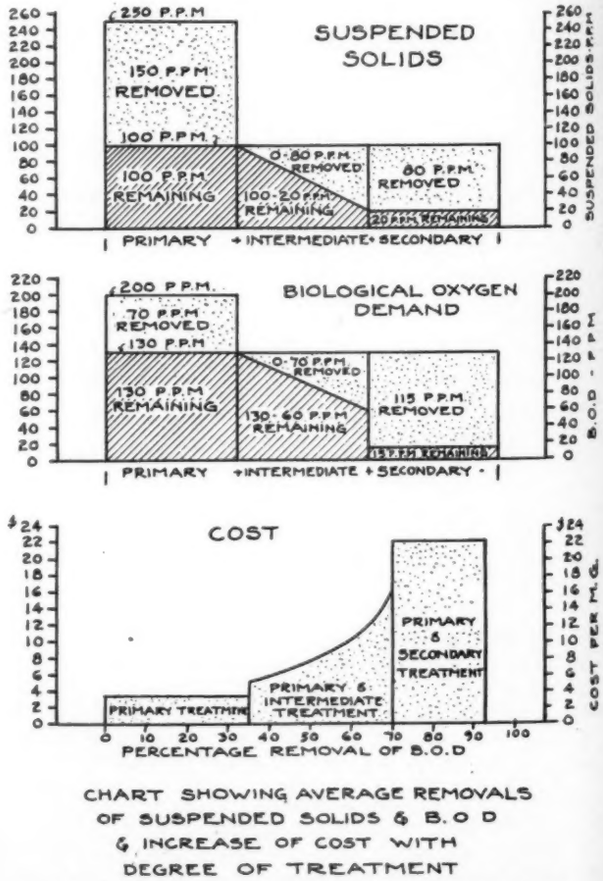

Fig. 2. Evaluation Graphs, Showing the Position of Intermediate or Chemical Treatment in Respect to Performance and Costs.

obscure the light in reading the turbidity there must be sufficient particles in the liquid to form a screen over the cross section of the tube. These particles, if settled, would form a layer not much thicker than the diameter of one particle. For a turbidity of 200 p.p.m. a depth of 10.9 cm. of liquid is required, and a layer of particles about 2 diameters thick is dispersed in a depth of 10.9 cm. For a turbidity of 100 the same quantity of particles would be distributed in a depth of 21.5 c.m. It is obvious that the particles are quite widely separated, and in quiescent settling the opportunity for collision of particles is not great.

The Selection of Coagulant

Much has been written about iron salts but only casual mention has been given to alum. The writer has always had a friendly feeling toward alum, from water practice where under certain conditions alum worked better than iron and lime. In general alum seemed to "hit" waters with finely divided suspended matter better than iron, which performed best with high turbidities of relatively coarse material. In trade waste work also, alum has proved superior in several cases. Experiments on chemical treatment at Lakewood, N. J., made by E. A. Bell of Clyde Potts office showed that at this plant having a strong, stale sewage, alum could be used to best advantage. It could be used alone, without conditioning, at the prevailing pH of about 7. The use of only one chemical and the avoidance of pH control greatly simplifies operation.

A Place for Chemical Treatment

Chemical treatment is gradually coming down to earth after the burst of enthusiasm of a few years ago. We hear less of chemical treatment versus biological treatment. It does supply a method that will serve effectively and economically in locations where primary treatment is insufficient and secondary treatment needlessly expensive. Today it is especially useful in increasing the effective capacity of existing plants as at Plainfield, Freeport, Lakewood and elsewhere.

On Figure 2 are charts showing the reduction in suspended solids, B.O.D. and the relative cost of primary, intermediate and secondary treatment. These were shown at the October, 1933, meeting of the New York Sewage Works Association with Mr. Luther's paper. They illustrate graphically the definite place that chemical or intermediate treatment fills in the repertoire of sewage treatment.

Acknowledgment: This paper was presented by Mr. Gavett before the 1936 meeting of the New Jersey Sewage Works Association.

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S. E. Killam Made Deputy Chief Engineer

The Metropolitan District Commission of Boston has announced the promotion of Samuel E. Killam, Senior Civil Engineer, to the position of Deputy Chief Engineer. Mr. Killam will continue to supervise the work of the Distribution Section and will be the Directing Head of the Water Division during the absence of its Director and Chief Engineer, William E. Foss.

Mr. Killam entered the employ of the Metropolitan Water Board on August 3, 1897, and was placed in charge of the Distribution Section July 23, 1908. He is a member of the American Water Works Association, is a past-president of the New England Water Works Association and also the Engineering Societies of New England, and is now serving as vice-president of the Massachusetts State Engineers' Association.

Chris Bingham Joins Columbia Alkali

C. F. Bingham

Chris F. Bingham, of Richmond, Va., on August 25th will join the Columbia Alkali Company, manufacturers of chlorine and other water works chemicals, as Technical Service Engineer, specializing in service in the water works and sewerage fields.

Mr. Bingham, who was graduated in Chemical Engineering by the Virginia Polytechnic Institute, served as Assistant Engineer with the Virginia State Department of Health before taking the position as Superintendent of Filtration at Richmond, Va. In the latter position, which he has held for the past several years, Mr. Bingham, associated with Marsden C. Smith, Engr. of Water Supply at Richmond, has contributed much to the advancement of water treatment practices. He had a hand in developing the Richmond "flocculators"; an improved and economical process of using powdered activated carbon; improved and safe handling of chlorine; super-prechlorination; the adaptation of post ammonia-chlorine treatment for suppressing main corrosion; and, most recently, chlorinated-copperas as the coagulant now used at the Richmond plant, with higher efficiencies and economies resulting.

Mr. Bingham has been an active leader and a "wheelhorse" in the Virginia Water and Sewage Works Association—later the Virginia Section of A. W. W. A.—which he now serves as an officer. His pleasing personality, inventive ability and wealth of practical operating experience, will serve him well in his new position as Columbia's Technical Service Engineer.

Columbia Alkali's main plant, where the production of chlorine has recently started, is located at Barberton, Ohio. The company's main offices, to which Mr. Bingham will be attached, are located at 30 Rockefeller Plaza, New York City.

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Something Unique in Water Systems

Excelsior Springs, Mo., now boasts two municipally-owned water systems. One is a regular water works system; the other, the unique "System" known as the Mineral Water System, now municipally owned and operated.

From private owners, Excelsior Springs purchased important mineral wells and springs for which the city is well known. With a P.W.A. loan and grant of $647,000, and authority from the Legislature, the city is going into the mineral water business. To this end, it is constructing "The Hall of Waters" which, in addition to health and recreational features, will contain offices of all city officials and the Chamber of Commerce.

The Excelsior Mineral Water System will advertise, bottle and market the more important of the 10 curative waters which are piped direct from their sources to "The Hall of Waters" for local dispensing and bottling. Also will be operated a mineral water pool, and physiotherapy departments for men and women.

A commission of three, serving without pay, will manage and operate the Mineral Water System. Accounts of the new "system" are to be kept separate from all other municipal accounts.

This information comes from B. C. Alnut, City Manager of Excelsior Springs.

ELIMINATING SEWER STOPPAGES—EXPERIENCES AT THE LOS ANGELES WHOLESALE TERMINAL

By CATER A. GEIBEL

Chief Engineer, Union Terminal Company, Los Angeles, Calif.

The Author

OUR properties cover an area of about twenty-one acres in the Los Angeles wholesale district, and our tenants include packing sheds, vegetable washing concerns, creameries, candy manufacturers and many others too numerous to mention, all of which present a constant problem in connection with keeping their sewers free.

Naturally, a clogged sewer is an inconvenience of the worst type, and I believe that our solution to this vexing problem will be of interest and value to the readers of Water Works and Sewerage. First, let me cite a few instances of the exceedingly difficult conditions with which we were confronted at different times, and the many difficulties which we encountered in trying to correct them before the solution to our problem presented itself.

We have one stretch of basement floor drain, all of which is underground, and which serves part of our warehouse. This section, which is 550 feet long, became badly stopped up by a combination of codliver and other fish oils mixed with dirt from the floors. Use of a lye solution in an attempt to clear the stoppage only formed an extremely hard soap which was almost impossible to remove. The first 100 feet of this section was worked on intermittently for a period of several months, and was finally penetrated with a hand-snake, but was never thoroughly and satisfactorily cleaned. It was on the second 100 foot section that our real trouble commenced. Here we used three men armed with steam hoses and hand-snakes for a period of two full weeks, during which time it proved necessary to dig the sewer up in two different places. The job was then given up as hopeless as the stoppage seemed to be setting harder and the location of the drain had made it almost impossible to get at by these methods.

One of our tenants is a vegetable packing company using two four inch drains 150 feet in length. Through neglect, the strainers were left off the drains and the sewer became clogged with a highly insoluble combination of carrots and sand. Another tenant, an oleomargarine manufacturer, uses a sewer 500 feet long and varying from four to eight inches in diameter. Due to the nature of the waste products, this sewer used to require attention every week, and with the old methods—that is, entering by the cleanout stations which are at 100 foot intervals and cleaning with hand methods—it always required at least one-half day's time just to restore service.

Sewer Sweep Tried

The foregoing are just a few examples of what we were up against in trying to maintain a proper, efficient sewer service. A year ago we ended our trouble by installing a Werko Sewer Sweep which has since proved phenomenally successful, although at the start it must be admitted that we were very skeptical over the idea.

In the case of the vegetable packing house, the two 150 foot drains were thoroughly cleaned from end to end and freed of all carrots and sand in four hours, although there is no doubt in my mind but that at least a week would have been required by the old method. The line serving the oleomargarine manufacturer is now thoroughly cleaned from end to end in a little over an hour and is so well cleaned that it now needs attention only every three or four weeks, where it used to clog every week regularly.

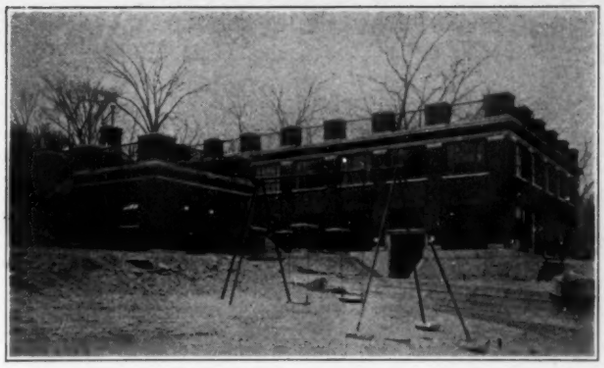
The basement drain, which had been given up as practically hopeless, of course presented the real test to the machine, but to our surprise, the machine penetrated the full 550 feet of drain just three and one-half hours, and the whole line was thoroughly cleaned and free from all foreign matter in one and one-half days' time from the start of the operation. We feel that the machine paid for itself many times over on this one job.

We have one line 600 feet long and 4 inches in diameter which can be thoroughly cleaned from end to end in one-half hour. By the old method, this line had to be cleaned in sections from three cleanout plugs, so a great deal of time is saved. The big item of time saving is essentially due to the fact that the machine is self-contained and requires no addition of tools. It actually revolves the cleaning apparatus and cable at from 500 to 600 R. P. M. at the same time unreeling the cable as the stoppage is penetrated. The machine is easily moved from place to place by one man, and is ready for moving as soon as the cable is withdrawn without any further cleaning up or gathering of scattered tools. The machine which we are now using employs a 28 inch wheel containing 600 feet of cable, and may be used in sewers from 4 to 12 inches in diameter. It uses a 1 H. P. 110-220-volt motor.

A Testimonial

We have found that our Werko Sweep will go through and clean any standard bend found on a sewer pipe. In the past year we have used it under a wide variety of trying conditions, having cleaned sewers stopped up solid with sand, walnut shells, leaves, and almost every imaginable form of hard rubbish.

The Sewer Sweep has ended our sewer stoppage troubles, and at the same time has reduced our maintenance costs materially. The cost of operating the machine is negligible and repair costs have been nil for the year, despite the tough jobs which it has been called upon to do. We may naturally be expected to be loud in our praise of the Werko Sewer Sweep.



The Kenilworth Filter Plant.
(Pearse, Greely and Hansen, Engineers.)

SUB-SURFACE FILTRATION AT KENILWORTH

By C. C. LEY
Supt. Water and Light Department, Kenilworth, Ill.

The Author

THE Kenilworth, Ill., Filtration Plant is equipped with two one-half million gallon filter units with beds 14½ feet wide by 12 feet long—an area of 175 square feet each.

The sub-surface filtering and washing system, invented and patented by Mr. Ira H. Jewell of Chicago, was installed in our South filter unit about two years ago and has proven very satisfactory. It has enabled us to obtain increased filter capacity 50 per cent above the normal 2 G.P.M. per square foot, and 100 per cent increase under favorable conditions of floc quality and turbidity coming over from the settling basins.

While operating one filter unit in the conventional manner and the other with the Sub-Surface System we have been able to make a comparison. We find that the Sub-Surface unit can and does give us more capacity under the same conditions of operation than does the conventional unit. Without any impairment to the clear and brilliant quality of the effluent, the Sub-Surface unit gives much longer runs between washings or can be operated at materially higher rates with less washing required—(See record graphs).

An order has now been issued to fit up our North filter unit with the Sub-Surface System so the entire plant will be operating with this system during the summer period when we have our peak demands.

Effective Filter Washing

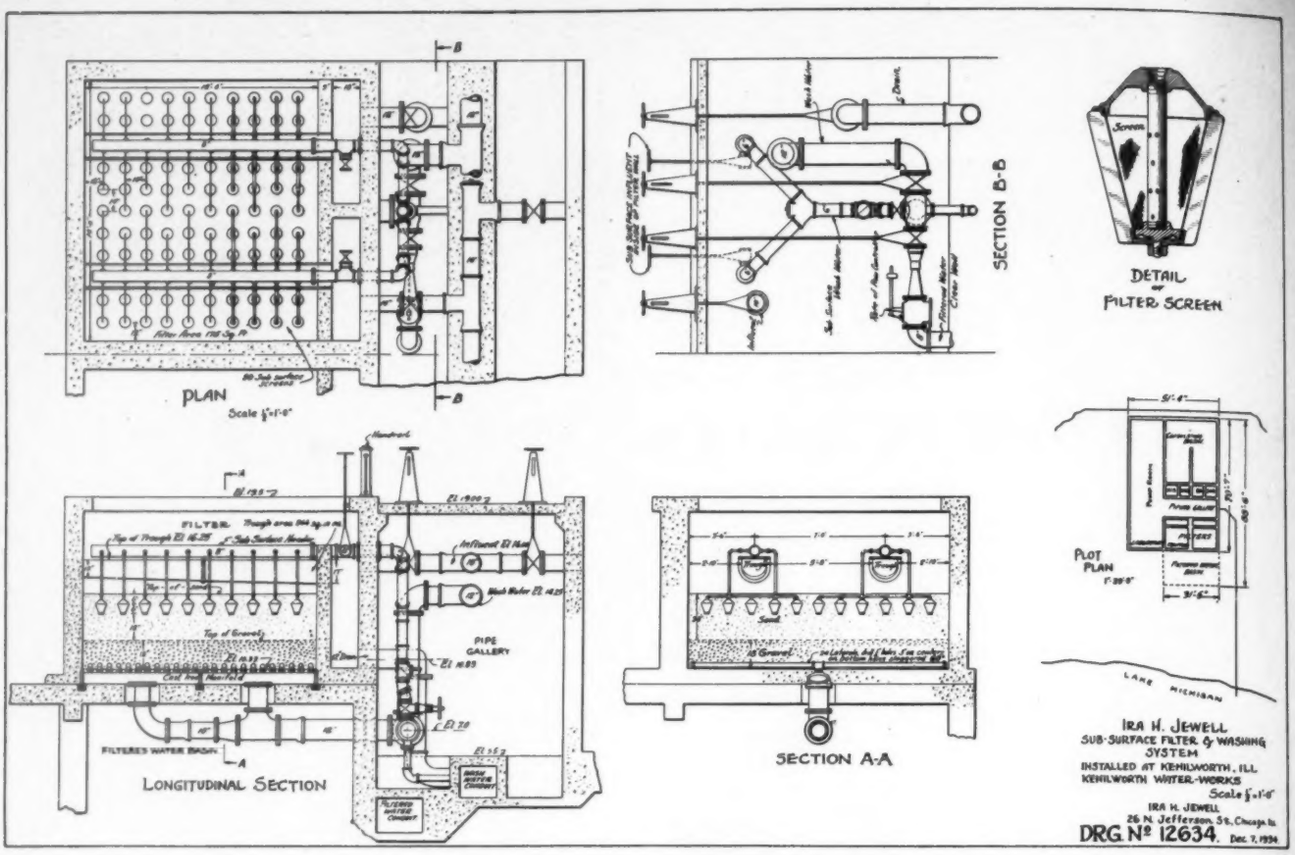
In filter washing the Sub-Surface System gives a very low expansion of sand, causing it to scour and agitate better than when higher rates are used for washing. This has effectively rid our filter of mud balls and kept the bed in a clean condition equal to new sand. Perhaps it is the water which emanates radially from each of the Sub-Surface screen distributors and sprays in conflicting streams to the upward wash (forming so to speak an "Hydraulic rake action" in scouring the sand bed) which has proven very effective. In my opinion it is a substitute for the old mechanical rakes which were so helpful in the washing of filter beds.

Our filter is washed with a 30-inch vertical rise with a sand expansion of only 6 to 8 inches, or 20 to 25 per cent of the depth of our 30-inch sand bed. Unless the Sub-Surface conflicting streams are employed to break down this wide expansion it would be impossible to scour and clean the bed properly, because we found the expansion of sand using this same volume to be enough to spill some fine sand into our troughs. These troughs are 24 inches above the bed level and we found the sand expanding from 50 to 60 per cent with high velocity wash of 24 to 30-in. vertical rise, before installing the Sub-Surface System.

We do not have any means to determine accurately the volumes of water used in washing from the underdrain system as against that coming through the intermediate Sub-Surface screens, but from information obtained from Mr. Jewell we believe this new method of washing is using from 20 to 30 per cent from below the bed and 70 to 80 per cent passes through the Sub-Surface members.

It might be mentioned that our peak demands during the summer months were so great that it was difficult to maintain the service, so in 1930 I built a rake device to drag across the top of the beds, with the rake bars having water jets to break up the surface of the bed and permit additional filtering without washing it. This

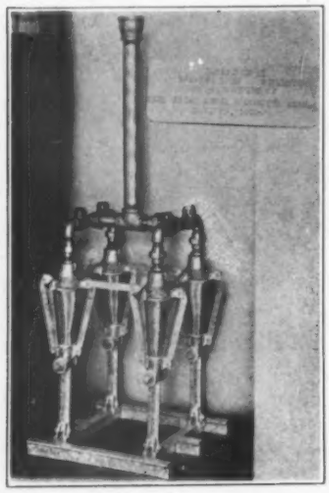
One of the Screens Dismantled, Showing Details of Its Three Parts.



Design of Jewell Sub-Surface System Installed at Kenilworth Plant.

method was used instead of using the so-called "bumping" of the filter which is frequently resorted to at such times by some operators. This rake device, however, is no longer used since installing the Jewell Sub-Surface filter system.

Our plant was originally built seven years ago. It was designed by Pearse, Greeley and Hanson, Consulting Engineers, and is equipped with dry chemical feed machines, rate controllers and laboratory equipment, according to the usual practice, and in all general respects represents a modern type of plant of that period. We make the usual daily examinations and culture plates and send monthly samples of water to the State Board of Health for analysis. During the entire time we have used the Sub-Surface System their reports have always been satisfactory.



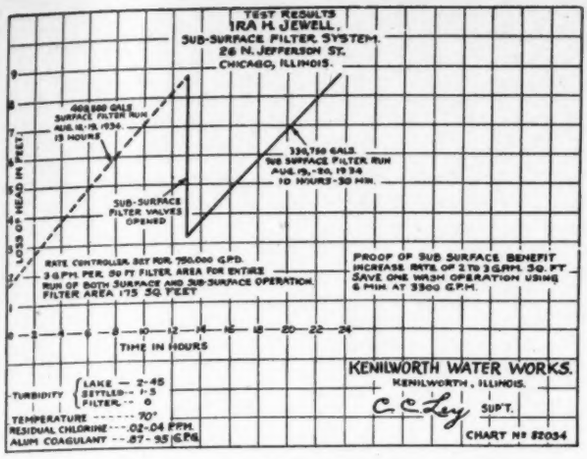
A Cluster of Four Screens Used in the Early Experimental Work.

Design of the Sub-Surface System

The Sub-Surface Screens are made of malleable galvanized castings with a stainless steel woven wire screen. I have examined them after two years in service and find no deterioration whatsoever, no rust and no difficulty with them, nor do we find the sand causing difficulty by passing through the screen mesh. This we believe is due to the fact that in filtering, as in washing, the water is always driving outward in the same direction—that is, from the screen into the sand. The tendency is, therefore, for the sand to be pushed away from the screens rather than toward or through them. No sand grains have lodged in the screen mesh nor have any passed through.

The arrangement consists primarily of a header line built to rest on the troughs or constructed to form a double section of them so the influent water for filtering and the filtered water for washing will be supplied to a series of Sub-Surface members (distributors) which are placed about 15 inches apart both ways at a depth of about 6 inches below the bed surface. In operation these units (such as the 110, used in our one-half million gallon filter) will sub-divide the applied water to stream uniformly within and below the surface of the bed for the double purpose of separately sub-surface filtering an additional supply of water to that passing through the bed surface, and also providing a scouring and agitating effect during washing. In addition, to apply the major volume of wash-water at the section of the bed where most of the impurities are retained.

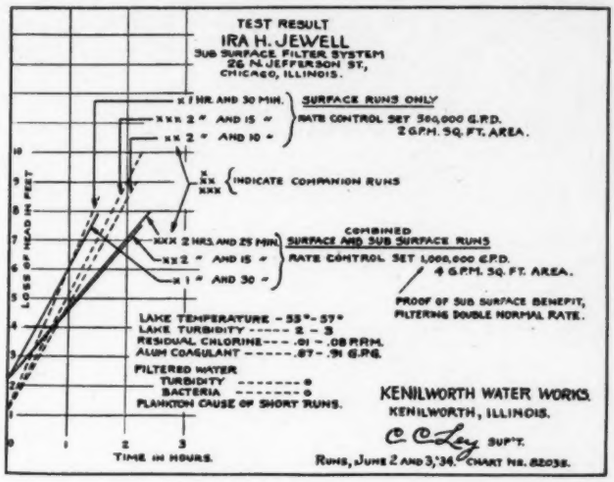
In filtering, my examinations have shown that a good quality of floc in the settled water coming over from the basins does not penetrate into the sand bed for more than about 2 to 3 inches at the normal rates, so that there is, therefore, a clean section of sand where the screens are placed which has never heretofore been utilized in filtering. In washing the bed with a small up flow volume from the under-drain system, while at the same time discharging more than double this volume



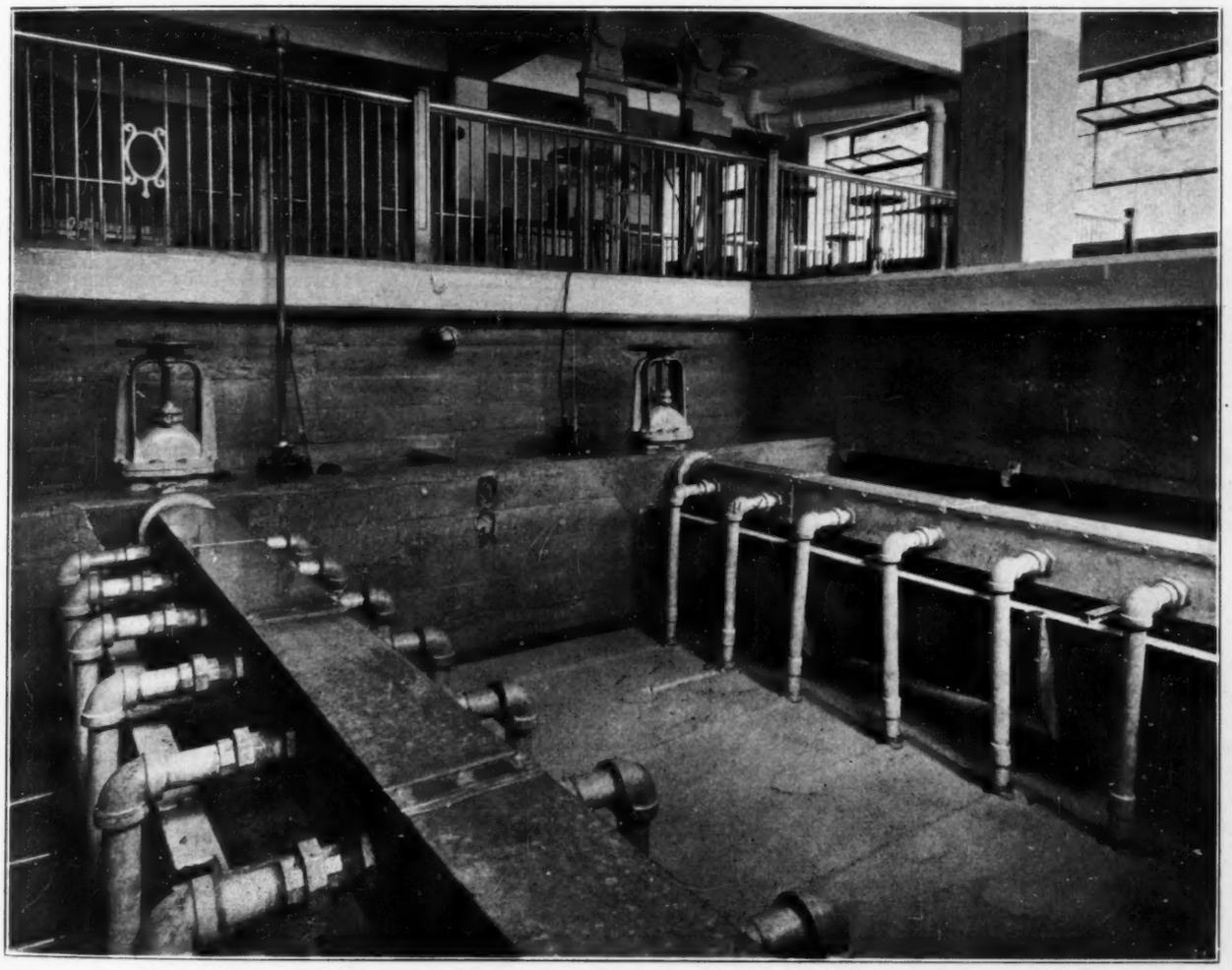
This record shows the additional water filtered through the sub-surface system after the filter had completed its normal run as an ordinary filter.

from the sub-surface distributors in a sidewise or oblique angle to the upward stream, I find there is a rapid and effective scouring of the sand bed, resulting in a quick wash.

I do not find the impurities caught within the upper layers of the bed, instead of wholly at the surface, have caused any difficulty to the filtered water stream passing down from the sand surface, and I am also of the opinion that the effective filtering area of the Sub-Surface members is based upon the very large contact area of the woven wire screen with the surrounding sand body. Although in our plant this figures only approximately 50 per cent of the area of the bed surface, we are enabled to obtain the same effect as 100 per cent area increase when the floc formation, turbidity and all



This record shows the relative rate of loss of head increase when the filter operated as an ordinary filter at design rate of 0.5 M.G.D. and that observed when operated with the sub-surface system in addition, but at double the design rate, during a short run period caused by plankton.



One of the Kenilworth Filters Equipped with the Jewell Sub-Surface Filtering and Washing System.

factors of operation are at their best. The accompanying performance graphs and illustrations tell more than many more words could.

FILTER RUNS TAKEN FROM CHARTS OF THE KENILWORTH PLANT.

Rate G.P.M./Sq.Ft.	Run	Hrs.	Min.	Gallons Water Filtered
3	Surface and Sub.	14	15	448,875
3	Surface only	—9	10	288,750
		5	5	160,125
3	Surface and Sub.	5	20	168,000
3	Surface only	—3	25	107,625
		1	55	60,375
3	Surface and Sub.	6	15	196,875
3	Surface only	—3	15	102,375
		3	0	94,500
2.2	Surface and Sub.	11	35	267,575
2.2	Surface only	—7	5	163,625
		4	30	103,950
2.2	Surface and Sub.	10	15	236,375
2.2	Surface only	—6	0	138,600
		4	15	98,175
3	Surface and Sub.	5	0	157,500
2	Surface only	—3	0	63,000
		2	0	94,500
3	Surface and Sub.	2	0	63,000
2	Surface only	—1	15	26,250
		0	45	36,750
4	Surface and Sub.	1	45	73,500
2	Surface only	—1	45	36,750
		0	0	36,750

Short runs due to plankton condition.

Acknowledgment: This paper was read before the Illinois Section of A. W. W. A. at Evanston, Ill., April, 1936.

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An Interesting Method Of Promoting Interest

The Los Angeles' *Intake*, published monthly by the Publicity Division of the Department of Water and Power of the City of Los Angeles—primarily intended for its employees, but also a publicity medium—has been running a series of "Questions and Answers" which adds to the knowledge of employees and creates interest in the functions and properties of the Bureau of Water Supply.

Following is a specimen taken from one issue of the *Intake*:

PICK THE CORRECT ANSWER

Here is another list of questions on matters relating to the Department. Following each question are five answers, only one of which is correct. Check each number you believe to be correct, then check your accuracy by referring to the page listed below.

1. Most of the pipe used in the distribution system of the Water Bureau is fabricated from (1) concrete; (2) steel; (3) wood; (4) cast iron; (5) aluminum.

2. A 50 cycle electric clock when connected to a 60 cycle source of power supply will gain in every hour (1) two minutes; (2) 12 minutes; (3) six minutes; (4) five minutes; (5) 10 minutes.

3. The number of electric and water meters read during the last fiscal year is closest to which figure? (1) 2,000,000; (2) 3,000,000; (3) 11,000,000; (4) 4,250,000; (5) 5,200,000.

4. Rated horsepower of the hydro electric generators at San Francisquito Power Plant No. 1 is (1) 96,200; (2) 75,800; (3) 45,500; (4) 68,400; (5) 110,400.

5. When the Mono Basin water development program is completed, how many additional second feet of water are expected to be made available to the City? (1) 85; (2) 135; (3) 92; (4) 76; (5) 112.

6. A horsepower is equal to (1) 467 watts; (2) 674 watts; (3) 764 watts; (4) 476 watts; (5) 746 watts.

7. How many district and branch offices are operated by the Commercial division? (1) 18; (2) 17; (3) 12; (4) 22; (5) 19.

8. Name the present members of the Board of Water and Power Commissioners.

(*Turn to page 23 for the correct answers*)

On page 23 the following:

ANSWERS TO QUESTIONS

Correct answers to the list of questions on page 2 are: 1. (4); 2. (2); 3. (5); 4. (1); 5. (2); 6. (5); 7. (1); 8. Dr. John R. Haynes, President; Alfred Lushing; Arthur J. Mullen; W. H. Hay; A. F. Southwick.

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Birmingham's Industrial Water System Advancing Rapidly

Birmingham, Ala., has well under way its new Industrial Water Supply System—a betterment long desired by the city and its many importance industrial works, which for the most part are large users of water such as has been available, in none too satisfactory quality and quantity, from the streams in and near Birmingham.

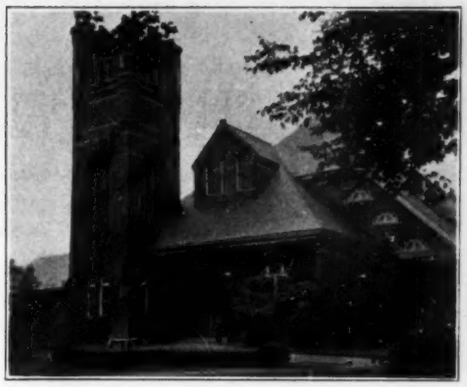
The project, which is being financed jointly by P.W.A. and W.P.A. has been designed and is being executed under the complete charge of a specially formed Engineering Commission consisting of City Engineer J. D. Webb (Chairman); O. G. Thurlow and A. Clinton Decker, Sanitary Engineer of the Tenn. Coal, Iron and Railway Company. In direct charge of the project A. C. Polk, well known Birmingham engineer is Executive Engineer, and Harry H. Hendon, Sanitary Engineer of Jefferson County, is Resident Engineer.

The Birmingham Industrial Water Supply System will consist of a large impounding reservoir, near Inland, Ala., delivering water through a 60-in. steel pipe line (welded pipe, jointed with flexible sleeve-type couplings), to a distribution reservoir and chlorination plant near Ketona. From the distribution reservoir the 60-inch line continues on to the outskirts of Birmingham where the water will enter the distribution mains. The latter will consist of flexible coupled steel pipe from 54 to 42 inches in diameter and Cast Iron pipe (also with flexible joints), for the smaller size mains.

The system will contain better than 27 miles of 60-inch steel pipe; almost two miles of 54-inch; about 7 miles of 48-in; and, 4 miles of 42-inch. In all, very nearly 50 miles of supply and distribution pipe is to be required. Bids have been taken and contracts awarded Chicago Bridge and Iron Works and Ingall Iron Works of Birmingham for the pipe, and to S. R. Dresser Mfg. Co. of Bradford, Pa., for the flexible couplings. In a future issue an article more adequately describing the project, the work on which is now going forward rapidly, will appear.

PENNA. WATER WORKS CONFERENCE FEATURES PLANT PROBLEMS

Reported by HARRY A. FABER*



The Old Armory at State College, Where the Meetings Were Held.

MEETING for the Ninth Annual Conference, June 22, 23, and 24, at State College, the Pennsylvania Water Works Operators' Association offered a program of high practical value to the better than 200 registrants.

The afternoon of the first day those in attendance were conducted on a tour of nearby quarries and mills of member firms of the National Lime Association and were given an opportunity of studying methods of producing and processing of lime. In the evening, President C. L. Fox, presiding at the first technical session, welcomed members and guests and introduced Dr. F. N. Speller, Metallurgical Engineer of the National Tube Co., who discussed corrosion problems.

Chas. L. Fox
Wilkinsburg, Pa.
Retiring President

Wm. C. Emigh
Coatesville, Pa.
President-Elect

Each year the association awards the President's Cup in recognition of the best paper presented by an operator as judged by the prize award committee. W. C. Emigh, Chairman of the Awards Committee, announced the cup had been won this year by Ned R. Ritchie, Manager of the Everett Water Company, Everett, Pa. The President's Cup was donated two years ago by H. M. Freeburn, then president of the association, and to receive the award is considered a distinct honor. Of the other papers submitted, that by Henry R. Welsford, Superintendent, Belmont Filter Plant, Philadelphia, was awarded second prize.

Officers Elected at Business Session

Following the presentation of the prize papers, on the morning of the second day, officers for the coming year were elected. They are:

President, Wm. C. Emigh, City Engineer, Coatesville, Pa.

1st Vice-Pres., G. Webber Knight, Manager, Natrona Water Co., Natrona, Pa.

2nd Vice-Pres., James C. De Groot, Supt., Clear Springs Water Co., Northampton, Pa.

Secy.-Treas., I. M. Glace, Cons. Engr., Harrisburg, Pa.

Secy. Glace reported that the active membership list of the association had grown to 340. Progress was reported in the promulgation of a licensing act and the committee is to continue its work. A correspondence course for filtration plant operators was recommended by Prof. Elton D. Walker to replace the short school. Members approved the appointment of a committee to develop the course through the cooperation of operators, the State Health Department, and the extension faculty of Pennsylvania State College.

The entire afternoon session was devoted to a symposium on operating problems and a "Peddlers' Party" featured the evening dinner at the Nittany Lion Inn. W. J. Orchard, Wallace and Tiernan Co., presided as master of ceremonies, and with his assisting quartette consisting of Joe Wafer, George Norcom, C. L. Seibert and B. H. Brock, made the session an hilarious one. In appreciation, E. C. Trax, a past president of the association, conferred on the master of ceremonies the rare honor of membership in the "Ancient and Honorable Order of Influent and Effluent Protectors."

In the final session, papers on jointing compounds and paints for water works were presented and the meeting adjourned to cheer its members in a golf tournament with the Penna. Sewage Works Association Conference. [The meeting of the Sewage Works Association was reported in our July issue.—Ed.]

Operators Present Prize Papers

"Importance of Water Works to the Community," was the title of the first prize paper. This was read by W. C. EMIGH in the absence of the author—N. R. Ritchie. The importance of a water works was described as being measured by the value of the service rendered. A dependable water supply definitely demonstrated its value during the recent floods affecting many industrial areas of the country. The temporary failure of other utilities to function causes no great suffering or danger, but community distress and hazards are certain to follow the failure of a water supply. During the flood conditions the great majority of water supplies rendered uninterrupted service—thanks to the untiring efforts of water works operators.

But it is even more essential that every day of our lives such supplies shall function properly. The threat

*Asst. Engr., The Chlorine Institute, New York, N. Y.

of typhoid has been largely eliminated, property is protected from loss by fire, general sanitation is improved, gardens and lawns are saved from summer droughts, local residents are given employment—all these are essential values of a community water works. Despite the importance of their jobs, water works activities are, unfortunately, seldom recognized as headline news.

The second prize paper, **"A Filtration Plant Sans Tache,"** presented by H. R. WELSFORD of Philadelphia, discussed the application of available knowledge to produce a plant "Sans Tache" (without blemish) and superior plant operation. So many difficulties of operation may occur that hardly a plant can point with pride to five years of perfect service. Mud balls, a common

E. E. Bankson, Chester Engrs., Pittsburgh, Pa.
G. A. Sward, Natl. Paint & Varnish Assoc., Washington, D. C.
H. W. Webber, Mgr. Water Co., Pottsville, Pa.

complaint, may be caused by unequal distribution of wash water and by accumulation of zoogleal masses. Surface wash, sand cleaning, alteration of under-drains and variation of wash rate have all been applied to the solution of this universal problem. The importance of careful chlorination control to insure dependable sterilization with varying conditions was stressed. Deserving of further study at most plants are problems of coagulation economy, taste and odor control, and filter operation efficiency.

The Mechanism of Corrosion

"Elements of Corrosion," by DR. F. N. SPELLER, Metallurgical Engineer, National Tube Company, Pittsburgh, Pa.

In discussing the fundamentals of this problem informally and using slides for illustration, Dr. Speller described the cause of corrosion as being fundamentally simple. All but the noble metals, like gold and platinum, are unstable and try to revert to the combinations such as oxides, carbonates, etc., in which they are found originally. The solution of a metal in water is accelerated by rate of water motion, temperature, and acidity of the water. Reducing the oxygen and forming protective films or deposits will reduce the rate of solution. Corrosion in the atmosphere is slow until the relative humidity exceeds 70 and is accelerated considerably by the presence of dust and sulphur dioxide in the air.

That the environment controls the rate of corrosion was proven by tests extending over a 12-year period. Action on steel, wrought-iron, and cast-iron proved to be practically the same with respect to rates of penetration. Recent tests by the author on wrought iron 1700 years old showed the rate of corrosion of this iron in Pittsburgh water to be the same as that of modern wrought-iron or steel when exposed side by side. A low-cost alloy steel containing small amounts of chromium, silicon, and about as much phosphorous as wrought-iron has recently been developed and is now made in the form of pipes and sheets. This metal has at least four times the resistance to atmospheric corrosion and two to four times as much resistance to water corrosion as ordinary steel or wrought-iron.

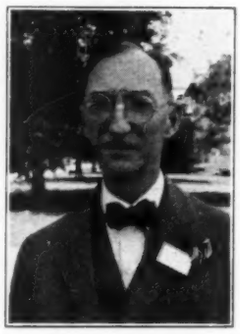
A deposit such as a tubercle of rust or a pinhole remaining from cleaning will produce a galvanic potential, localize and hasten further attack. The methods of preventing corrosion are by improving the resistance of the metal, by retarding the action of the environment, and by the application of protecting coatings. The economical solution for the present is by the use of protecting coatings. Alkali treatment of water, bituminous linings, and external coatings on pipes are all well understood, and soil corrosion troubles are not widespread.

In answer to a question, Dr. Speller stated that silicates could be used for production of a protective coating inside the pipe. George Norcom, Consulting Engineer, New York, said the decrease in carrying capacity due to corrosion was an economic factor little considered. H. E. Beckwith, Pitometer Company, Harrisburg, added that coefficients for pipes in use a relatively short time are generally much lower than the values indicated by the Williams and Hazen tables.

"Comparative Studies with Anthrafilt and Filter Sand as Filter Media at the Bethlehem Water Plant," by R. W. WOODRING, Chemist and Bacteriologist, Bethlehem, Pa.

With the heavily polluted Lehigh River, carrying sewage and acid mine wastes, as the source of raw water supply, Mr. Woodring reviewed the difficulties of filter washing in this plant with the limited wash water supply available. A rotary compressor giving an air wash at 5 lb. pressure, and centrifugal pumps delivering 2,500 g.p.m. of wash water, are used. Floc formation on the filters is poor because of a 3 to 10-foot fall in delivering coagulated water.

Two filter units (6 m.g.g. capacity) on opposite sides of the gallery were used, one containing anthrafilt (crushed and graded anthracite) and one sand for comparison. Under-drains of both were overhauled and



J. E. Goodell
City Chemist
Lancaster, Pa.

L. S. Morgan
(Pa. Dept. of Health)
"Master of the Question Box"

each contained 14 inches of gravel and 26 inches of sand or anthrafilt. Tests extended from March, 1934, to March, 1935, with daily chemical and bacteriological tests according to Standard Methods of Water Analysis. The depth of filter media in the two beds, the minutes of wash required, per cent expansion during washing, and water temperature were carefully checked. When placed in service, analyses showed the effective size of the sand to be 0.34 m.m.; of anthrafilt 0.39 m.m. After six months of continuous operation the sand was 0.32 m.m., the anthrafilt 0.42 m.m., and after one year, sand 0.51 m.m., anthrafilt 0.66 m.m.

With the bacterial load increase in warm weather, pre-chlorination is used—the chlorine being applied,

however, immediately ahead of the filters. The filters are washed every day and while a two-inch greater loss of anthrafilt was found than sand, a wash water saving of 10 per cent was noted on the former. In summarizing, Mr. Woodring pointed out that chemical, physical and bacteriological tests showed no advantage in favor of either medium. The washing, with better bed expansion and less water consumption, was markedly in favor of the anthrafilt. The per cent expansion of anthrafilt to sand averaged 5 to 1. In this plant, where the wash rate cannot economically be increased, the use of anthrafilt is desirable—because of the ease of bed expansion with less wash water velocity.

O. A. NEWQUIST, Chemist, Westmoreland Water Company, Greensburg, Pa., discussed the paper and reviewed operation experiences at the Greensburg plant, where anthrafilt was being used. The water is aerated, treated with 0.2 gr. per gal. of alum, and has only a 45-minute detention in the basin before being applied to the filter. The filters have a heavy floc load. One filter unit contained gravel and sand, and another gravel and anthrafilt. The operation of the plant averaged 8 hrs. a day. Turbidity and B. coli removal of both filters had been practically the same, but the anthrafilt unit showed longer runs with less wash water consumption. Bacterial load applied to the filters had been low at all times.

H. G. TURNER, Research Engineer, The Anthracite Institute, stated that anthrafilt medium is used in several boiler water treatment installations and in pressure filters at Little Falls, N. J. Twenty-six states had at least one anthrafilt unit in use. He said that anthrafilt in use at a softening plant had acquired a coating of carbonate which flaked off when dry, whereas acid had been required to remove similar coating from the sand previously used. In Mr. Woodring's experience, manganese coating could be removed from anthrafilt with little difficulty. K. R. Adams reported that with lime and alum

Harry J. Krum
City Chemist
Allentown, Pa.

H. G. Turner, Engr.
Anthracite Institute

as coagulants, a brown accumulation had appeared on anthrafilt but was easily removed.

L. S. MORGAN, Engineer, State Department of Health, who read Mr. Newquist's discussion, stated that several plants using anthrafilt have been approved by his department. Mr. Turner added that if all bacteria are to be removed, filters must contain fine material, but that in his opinion a 24 to 30-inch bed of anthrafilt with an effective size of 0.60 m.m., would perform the same work as 0.43 m.m. sand.

"Jointing Compounds," by DR. C. R. PAYNE, Research Chemist, Atlas Mineral Products Company, Mertztown, Pa.

Dr. Payne limited his subject to sulphur base compounds because these are of especial interest to water works engineers. The permanence, strength, and chemical inertness of these sulphur compounds are explained by the properties of the constituents. Research had shown sulphur an ideal plasticizing agent and an inert aggregate must be properly selected. Sulphur, inert to most acids and corrosive salt solutions, when properly proportioned, the type of aggregate determines the workability of the cement. Bonding for metal surfaces is improved by the use of plastic materials, and greater resistance to mechanical shock is obtained. A test of 4-inch C.I. pipe, joined with sulphur cement, with a length of 1 ft. between supports, showed it to be intact after 90,000 impacts from a 50-lb. weight dropped 6 in. on the bell. Due to its acid resistant properties, this

Prof. E. D. Walker, Pennsylvania State College, State College, Pa.
Chas. J. Bruce, Mgr. Evitts Creek Water Co., Cumberland, Md.
Harry E. Moses, Prin. Asst., Engr., Pa. Dept. Health, Harrisburg, Pa.

material should also find use in jointing brick or tile sewer, or sewer liner plates, in sewage plant construction and in construction of acid-proof tanks to hold chemicals used in water and sewage treatment.

"Paint for Water Works," by GILBERT A. SWARD, Assistant Director of Laboratories, National Paint, Varnish and Lacquer Association, Washington, D. C.

Describing accelerated weather tests, Mr. Sward claimed there is no accurate way to predict action on protective coatings by these tests—that they are merely comparative. When used on concrete, paints must be designed to resist alkali. Paints were made resistant to bacteria, mildew and fungi through the use of bichloride of mercury, using one part of the salt in 500 to 1000 parts of paint. Tung-oil paints, coming into more general use, are rapid drying and resistant to alkalies. Laboratory tests for varnish and paint qualities were described by Mr. Sward in an interesting way.

C. J. BRUCE, Supt., Evitts Creek Water Company, Cumberland, Md., discussed the application of the technical data given as it applied to filter plants. The use of paint, he pointed out, has an important esthetic effect. Customer impressions are raised and better light for working conditions is another advantage in proper painting. Cumberland was contemplating the construction of an all-metal water plant similar to that at Burnt Mills, and the life of such a plant depends largely on the type of protective coating applied to the metal surfaces. Mr. Sward explained that the durability of paint on metals depends largely on proper treatment of the surface to which it is applied. Immediate application after sandblasting is best. Baking of the film should be done whenever possible as it improves the film. For this, portable electric heaters could be used.

Symposium on Operating Problems

Substituting for Martin E. Flentje, regular "question box" and symposium leader, L. S. Morgan propounded the questions. Operators and experts entering enthu-

siastically into the discussion, the symposium proved to be a feature of the meeting. Some of the questions and the answers follow:

"How often are distribution system samples taken?" —Geo. Taylor, Scranton, said not often enough. Purification plants are generally well covered, but not enough points are generally sampled to show what the consumer is receiving. Changes in conditions, rather than actual danger, would be indicated by more numerous distribution samples.

The President's Cup and Its Donor Past President Harry M. Freeburn

I. M. Glace (Long-Time Secy-Treas.) and F. N. Speller (Wrote a Book on Corrosion)

Harry Krum (Allentown)—Different taps are sampled but results are practically the same. However, scattered sampling has shown cases of local contamination and cross connections.

E. C. Trax (McKeesport)—A sewer pipe, supposedly sealed off, had proven to be the source of pollution in a district reservoir at times of heavy rain.

"What is the value of bacterial tests when water is used immediately?"

J. E. Godell (Lancaster) said the 48-hour results could be indicated by the 24-hour fermentation test, but that if residual chlorine was checked hourly and found to be correct, the bacterial quality would almost invariably be found satisfactory. The bacterial test was primarily valuable for purposes of confirmation and records.

J. C. Bell (Philadelphia)—Using Brilliant G. Bile may show results in 24 hours when pollution is heavy. Previous experience with a supply is of considerable help.

"How to decide when water mains should be cleaned?"

Mr. Brown (Columbus)—By testing of a section of the main for evaluation of flow and pressure losses due to friction set up by tubercules.

Mr. Naylor (Gettysburg)—When facilities are provided for obtaining the friction coefficient ("C" value) this is a dependable indication in determining when mains need cleaning.

"How long does the cleaning effect last?"

Dr. Speller (Pittsburgh)—The operator is concerned not with the life of the pipe, but with loss of capacity. Cleaning will hasten future tubercule formation by leaving pit-holes. The nature of the water is the determining factor in answering the question.

W. W. Brush (New York City) said that an active water would rapidly reform tubercules in a cleaned pipe.

"Has the chloramine treatment proven successful in combating tuberculation?"

H. A. Faber (New York City)—For over two years the city of Utica, N. Y., has maintained carrying capacity of a 42-inch main at nearly its maximum by this treatment alone, when ordinarily a large reduction in carrying would have been noted much earlier. No parallel experience had been reported but chloramine treatment had been successful at separated points in controlling corrosion in dead ended distribution mains.

▼

Harry U. Fuller Slated for Presidency of N.E.W.W.A.

The Nominating Committee of the New England Water Works Association has chosen Harry U. Fuller, Chief Engineer, Portland (Me.) Water District, to succeed Roger W. Esty of Danvers, Mass., as president of the association. The complete slate named by the committee follows and such nomination is tantamount to election:

H. U. Fuller

President—Harry U. Fuller, Chief Engr., Water District, Portland, Me.

Vice-Pres.—Geo. A. Sampson, Cons. Engr., Weston & Sampson, Boston, Mass.

Treasurer—Leland G. Carlton, Registrar, Water Department, Springfield, Mass.

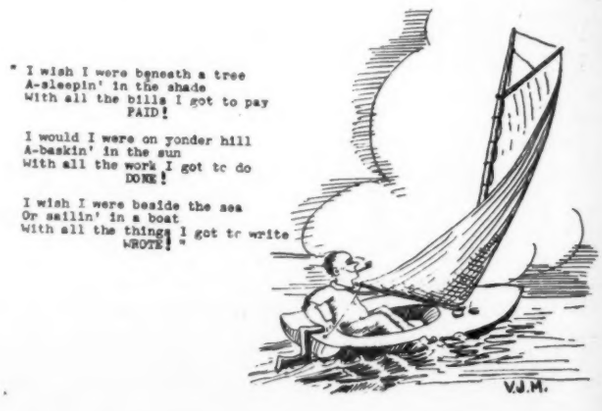
Director—F. H. Kingsbury, Sr. Ass't Engr., Mass. Dept. Health, Boston, Mass.

Mr. Fuller, now serving as Vice President of the Association, has for many years served as Chief Engineer of Portland's Water District and has been long active in N.E.W.W.A. and the Maine Water Utilities Ass'n, which he has recently served as president. This recognition of his abilities as a water-works authority and leader, as well as his pleasing personality, will be a source of great pleasure to his many friends and professional acquaintances. With much gratification, we add our high endorsement to this nomination. Our compliments to the committee, and our sincere wishes to the President Elect.

▼

The Thoughts of an Editor in August (and Those of Others)

P. S.—This "pome" and sketch came to Ye Ed from Victor J. Mill, President of Lawrence Machine and Pump Corp., on a hot afternoon. It struck home—and, so here it is.


I wish I were beneath a tree
A-sleepin' in the shade
With all the bills I got to pay
PAID!
I would I were on yonder hill
A-baskin' in the sun
With all the work I got to do
DONE!
I wish I were beside the sea
Or sailin' in a boat
With all the things I got to write
WROTE!
V.J.M.

General View of the Harlan, Iowa, Sewage Treatment Plant from the Digester

NEW SEWAGE TREATMENT PLANT FOR HARLAN, IOWA

By J. C. REYNOLDS, Omaha, Neb.
*Consulting Engineer**

THE City of Harlan, County Seat of Shelby County, Iowa, is an agricultural community of approximately 3500 people. It is located on State Highway No. 7 about 50 miles east of Omaha, Neb., and is served by the Great Western, North Western and Rock Island Railroads. The enterprise and progressiveness of this town are attested to by the fact that they have a modern water works, an electric power plant, a library, a new Post Office and an up-to-date City Hall. And, more recently, a new sewage treatment plant, concerning which this article is written.

In the fall of 1935, due to desire and necessity for eliminating the pollution in the Nishnabotna River, the city retained the writer's firm to design and supervise construction of the sewage treatment plant. A plant site was selected near Highway No. 7, adjacent to the Nishnabotna River. Because of its proximity to the town, the Council decided that the plant should be of a type free from objectionable odors and that its general design

The Laboratory

must be attractive for obvious psychological reasons. Consequently, the activated sludge type of treatment was selected.

At present, only about two-thirds of the population of Harlan are connected into a sanitary sewer system. The type of sewage is almost wholly domestic, but is fairly high in strength, due to limited infiltration into the sewers.

*Of Nixon and Reynolds, Engrs., Omaha, Neb.

Usually the sewage flow of a community parallels very closely the daily amount of water pumped by the water works, but not so in the case of the City of Harlan. The normal fresh water pumpage at present is 300,000 G. P.D. with a maximum of 450,000 G.P.D. during the summer months. A large part of this pumpage is used by the three railroads previously mentioned. They discharge nothing into the sewers.

The treatment plant was designed on the basis of a sewage flow of 60 gallons per capita per day for 3500 people, or 210,000 gallons per day. Since the plant has been in operation, the fresh water pumpage has been normal while the sewage flow has averaged 134,000 G.P.D., which is equivalent to 62.82 gallons per capita on the present connected population.

General Plant Design

The plant consists of a comminutor chamber equipped with two 10-inch comminutors, supplied by the Chicago Pump Co., a hopper bottom primary sedimentation tank without collecting mechanism; two "Chicago" Combination Aerator and Clarifier units; sludge pumping equipment; unheated sludge digester and sludge drying beds. The primary settling and aeration portion of the plant has been designed for a flow of 210,000 G.P.D. with a maximum hourly flow at the rate of 420,000 G.P.D. The comminutors, sludge pumping equipment and building are designed to take care of a flow of twice that amount. Space has been provided so that to double the capacity of the present plant it will only be necessary to duplicate the present primary tank and the two "Chicago" Combination Aerators and Clarifiers.

Plant Operation

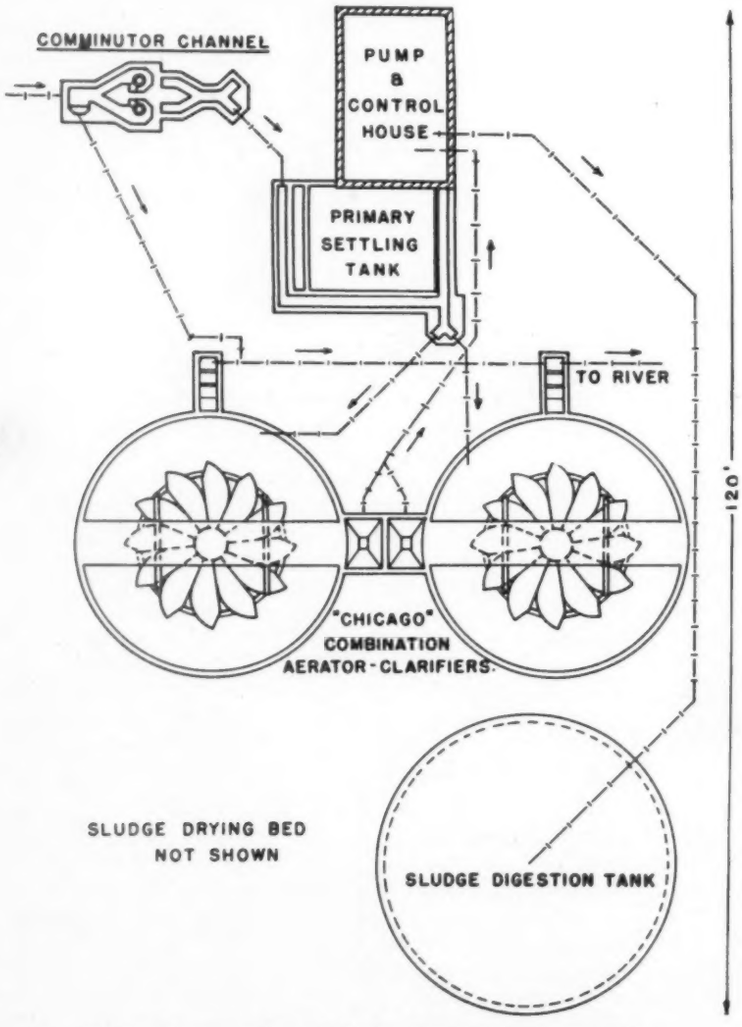
The sewage flow to and through the plant is entirely by gravity. Arriving at the plant it passes directly into a structure equipped with two 10 inch comminutors, which are machines for cutting up the coarse material, such as rags, sticks, etc., in raw sewage. The solids are cut up as the sewage flows through the comminutors. The operator has no screenings to handle, because the

comminuted solids settle out in the primary settling tank with the sludge and are pumped to the digester.

The beginning of the comminutor structure is provided with an adjustable weir and by-pass so that excess storm flows are automatically by-passed around the treatment plant. The normal sewage flow is passed through one or the other comminutor as desired. In this way, a stand-by unit is always available. Each unit is equipped with a 12-minute-cycle time-clock control, and since the plant has been in operation the comminutor being used has been running 8 minutes out of every 12. This has been found to be sufficient to cut up quickly all the coarse material as it arrives at the machine and at the same time the program conserves power.

From the comminutor the sewage flows to the primary settling tank which provides for a detention time of one hour and 8 minutes, based on the average design flow of 210,000 gallons per day. The tank, measuring 12 ft. x 17 ft. in plan, is constructed so that the sewage enters one end through seven submerged ports behind a concrete baffle, or scum wall, and leaves the opposite end over an adjustable weir 12 ft. long. The bottom of the tank is sloped at 60 degrees from all sides to form a hopper, or sump, in the center, from where the settled solids can be pumped. Each day the plant operator squeegees the sloping tank bottom to move any sludge that might tend to accumulate in the corners.

The flow from the primary settling tank is equally divided between two "Chicago" Combination Aerator and Clarifier Units. Each unit consists of a 16-foot diameter hopper-bottom metal tank set within a 30-foot diameter concrete tank having a side water depth of 5 ft. 4 in. and a maximum depth of 12 ft. 6 in. The inner compartment is the final clarification tank. It provides a deten-



Harlan, Iowa, Activated Sludge Sewage Treatment Plant

OPERATING RESULTS HARLAN, IOWA, SEWAGE TREATMENT PLANT.

Date, 1936	Temp. C.		Flow Data Detention Period				East Aerator Settleable			West Aerator Settleable			Dissolved Oxygen		Five day B.O.D.						Suspended Solids						pH		
	Raw	Aerators	1000 G.P.D. Flow to Plant	Primary Tank Hr.	Aeration Period Hr.	Final Clarif. Hr.,	Final Rate Gal./sq.ft./da.	15 Min. %	30 Min. %	Suspended Solids ppm	Mohlman Index	15 Min. %	30 Min. %	East Aerator ppm	West Aerator ppm	Raw ppm	Primary Effluent ppm	East Aerator Effluent ppm	West Aerator Effluent ppm	Combined Effluent ppm	Av. B.O.D. Reduction %	Raw ppm	Primary Effluent ppm	East Aerator Effluent ppm	West Aerator Effluent ppm	Combined Effluent ppm	Average Reduction %	Raw	Primary Effluent	Aerator Effluents
Mar.																													
2.....	7	6	...	...	...	...	...	3	3	810	37	..	5	7.4	2.6	135	67	10	10	10	93	...	...	..	..	..	..	7.8	7.6	7.4
3.....	7	6	161	1.4	7.	3.3	510	3½	3	860	35	5	4	5.7	3.2	116	65	12	16	14	88	640	107	80	67	74	88	7.8	7.8	7.6
4.....	9	7	146	1.5	7.5	3.7	460	5	4	1120	36	5	4½	4.4	3.6	160	101	11	13	12	92	...	...	..	..	50	..	7.8	..	7.5
5.....	9	10	143	1.6	7.7	3.8	450	5	4	1080	37	5	5	4.7	4.3	150	100	7	10	9	94	360	73	65	67	66	82	7.8	7.8	7.6
6.....	10	11	132	1.7	8.7	4.2	420	7	5½	980	56	6	5	..	4.4	236	110	9	11	10	96	515	90	32	37	34	93	7.8	7.7	7.6
7.....	10	11	105	2.1	10.5	5.1	330	11	7	1010	69	5	4½	7.2	5.6	198	112	6	11	8	96	450	70	18	12	15	97	7.7	7.7	7.7
Sun....	..	..	117	1.9	9.4	4.6	370	..	..	....	...	..	...	..	..	...	...	..	..	..	..	...	...	..	..	..	..	..	..	..
9.....	10	9	136	1.7	8.5	4.0	430	..	9	930	97	9	7	4.3	4.3	230	150	14	15	15	93	485	108	38	38	38	92	8.1	7.8	7.6
10.....	12	11	132	1.7	8.7	4.2	420	22	14	1170	120	..	9	1.5	1.0	176	66	10	8	9	95	635	142	28	34	31	95	7.8	7.8	7.6
Ave....	9	9	134	1.7	8.6	4.2	420	8	6	995	...	6	5½	5.0	3.6	175	96	10	12	11	94	514	98	43	43	43	92	7.8	7.7	7.6

tion time of 2.8 hrs. and an upward velocity of 640 gallons per square foot per day. The outer compartment is the aeration tank. It provides a holding capacity equivalent to a detention time of 5.7 hours, based on the average daily design flow plus 20 per cent sludge return. In the center of the structure is a draft tube through which the mixed liquor in the aeration compartment rises from the bottom of the tank and is thrown out over the splash plate, which acts as a tight cover for the settling compartment—see picture.

The settled sewage from the primary tank enters the aeration tank at the side near the top, where it mixes with the aerating liquor as it moves in a downward motion toward the bottom of the draft tube. It rises through the tube and is thrown out over the splash plate where it is further agitated and aerated by going over hurdles. The circulation is of sufficient velocity to prevent any settling out of sludge.

The aerating mix (sludge-sewage mixture) is recirculated by the aerator at a rate of 3600 G.P.M., or a complete turnover of the contents of the aeration compartment once every 8 minutes for continuous running of aerator motor.

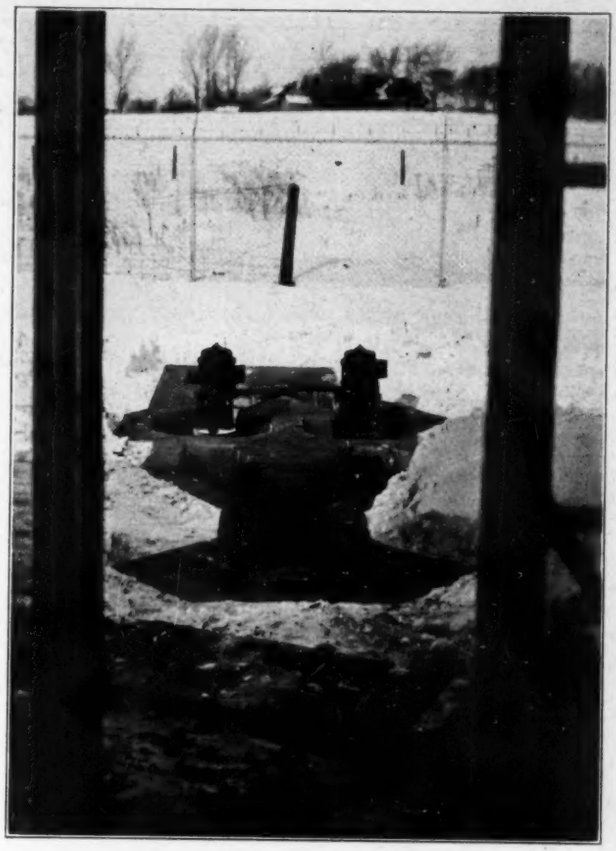
As sewage continues to flow into the tank the mixture of activated sludge and sewage gradually flows toward the center of the structure and finally enters the inner tank through an annular space between the clarifier tank wall and a circular baffle set inside it.

The sludge settles in the clarifier compartment. The clear liquid flows upward over a weir and into a circular launder around the draft tube. It then passes through a discharge pipe into a weir chamber outside the aerator, and then through a short outfall sewer to the Nishnabotna River. The weir chamber is connected to a float chamber in the basement of the control building, where a float actuates a Simplex Recording and Computing Flow Meter.

The sludge which settles out in the clarifier continuously drops through an annular opening between the bottom of the compartment and the draft tube, and is drawn up the draft tube with the aerating mix.

The amount of sludge constantly increases as raw sewage continues to flow into the plant. Some of the accumulation must be withdrawn and disposed of. For this purpose a separate concentration tank, or sludge pit, common to both aeration tanks has been provided. The amount of sludge withdrawn is regulated by adjustable gates between each aeration compartment and the sludge pit. These gates can be adjusted so that any desired amount of flow of the aerating mix may be diverted continuously into the sludge pit. As the contents of the sludge pit are practically quiescent, the sludge falls to the bottom. The supernatant liquor flows back into the aeration tank. The sludge is pumped

Close-up of Surface of One of the Aerators



The Twin Communitors and Channel. Seen from a Window of the Control House

to the comminutor chamber to mix with raw sewage and eliminate odors.

Manual operation at the Harlan plant has been reduced to a minimum by equipping each aerator motor with two 20-minute-cycle adjustable time clocks. Each clock may be set to operate motor any desired number of minutes out of 20. One clock is set to operate to meet the heavier sewage load during the day, and the other to care for the light night load. Considerable saving in power thus results over that which would be consumed if motors were operated continuously irrespective of the sewage load to be handled.

Sub-zero weather last February did not interfere with the operation of the "Chicago" Combination Aerators and Clarifiers at Harlan. Even when the temperature dropped to twenty degrees below zero, the aerators continued to function.

Plant Tests

The plant was placed in operation on February 6, 1936, but because of the extreme cold weather when the temperature was at least twenty degrees below zero every night, the activated sludge was naturally very slow to develop. In the east aerator, activated sludge started to develop on the 11th and a few tests run from February 12 to 21 indicated fair B.O.D. reductions. The west aerator, however, did not start to show much reduction in B.O.D until February 20. Sub-zero weather did not affect the activated sludge after it had developed.

From March 2 until March 10, tests were conducted daily to obtain operating data on the plant. Samples were collected hourly from 8 a. m. to 5 p. m., inclusive, of the raw sewage at the comminutor chamber, of the primary effluent, and of the effluent from each aera-

tor. These samples were composited, and at the end of each day suspended solids determinations were made and B.O.D dilutions were set up on each composite. Determinations of settleable solids, suspended solids, pH, and dissolved oxygen were made on the mixed liquor in each aeration unit every day. The temperatures of the raw sewage and plant effluent were recorded daily, as was the sewage flow as determined by the flow recording meters.

The results of the eight days of testing are shown in the accompanying summary data sheet. It will be noted that the Mohlman Index was low. This was probably because of the low temperature of the mixed liquor, because the data show that as the temperature of the mixed liquor increased during the period of the test there was a corresponding increase in the sludge index. Frequent microscopic observations of the sludge failed to show the presence of any protozoa until after March 6, or until the temperature in the aeration mix was above 10 degrees Centigrade.

The average results show that even with the handicap of the low temperatures in the aeration mix, the average B.O.D. reduction through the plant for the period of the test was 94 per cent and the average suspended solids reduction was 92 per cent.

Cost and Power

The Harlan plant cost $35,000 to construct. The east aerator consumes 2010 watts and the west aerator 1905 watts, or a total of 3915 watts.

The above power consumption is based on the automatic intermittent operation of the aerators by time clock control, in which during every 20 minute cycle the aerators are idle 5 minutes, or 25 per cent of the time.

There is a reason to assume that the same program will serve in treating the full design flow of 210,000 G.P.D., which gives a power consumption of 25 H.P. per M.G. at full loading.

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The Old and the New in Wheelbarrows

The above picture bearing the caption, "More Dirt—Less Push," caught our eye in a recent issue of *Aluminum News Letter,* the monthly publication of the Aluminum Company of America.

We have since learned that the "Hyb-Lum, all-aluminum, wheelbarrow is not new. It has been extensively used during the past year or more. The small size barrow (here pictured) weighs but 33 pounds, but has a dirt capacity of 2½ cubic feet. The larger size weighing but 3 pounds more (just about half that of the old style barrow) has a loading capacity of 4½ cu. ft. The wide pneumatic tire and frictionless bearings make for easy pushing and require no plank run-ways.

New and Old Barrows

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ASSOCIATION MEETINGS SCHEDULED:

AUG. 19-20—CLEVELAND, OHIO (Hotel Cleveland).
Central States Section, A. W. W. A. Sec'y-Treas., H. Floyd Nelson, U. S. Pipe and Foundry Co., 2437 Koppers Bldg., Pittsburgh, Pa.

SEPT. 14-17—SANTA MONICA, CALIF.
California Sewage Works Association. Annual Convention. F. D. Bowlus, 202 Law Bldg., Los Angeles, Calif.

SEPT. 21-22—FARGO, N. DAK.
North Dakota Water and Sewage Works Conference. Annual Convention. Sec'y-Treas., M. D. Hollis, Bureau of Sanitary Engineering, Bismarck, N. Dak.

SEPT. 21-23—DENVER, COLO. (Cosmopolitan Hotel).
Rocky Mountain Section, A. W. W. A. Annual Meeting. Sec'y-Treas., B. V. Howe, 437 State Office Building, Denver, Colo.

SEPT. 22-25—NEW YORK, N. Y. (Hotel Pennsylvania).
New England Water Works Association. (Annual Convention.) Secretary, Frank J. Gifford, Room 613, Statler Building, Boston, Mass.

SEPT. 23-24—HURON, S. DAK.
South Dakota Water and Sewage Conference. Sec'y, W. W. Towne, State Sanitation Board, Pierre, S. Dak.

SEPT. 28-OCT. 1—TORONTO, ONT. (Royal York Hotel).
Public Works Congress (American Society of Municipal Engineers and I. A. P. W. O.) Executive Director, Frank W. Herring, 850 East 58th Street, Chicago, Ill.

OCT. 1-2—COLUMBUS, OHIO
Ohio Conference on Sewage Treatment. Annual Convention. Sec'y., B. M. McDill, Department of Health, Columbus, Ohio.

OCT. 9-10—GENEVA, N. Y.
New York State Sewage Works Association. (Fall Meeting.) Sec'y-Treas., A. S. Bedell, New York State Dept. Health, Albany, N. Y.

OCT. 12-15—FORT SMITH, ARK. (Hotel Goldman).
Southwest Section, A. W. W. A. (Annual Convention.) Secretary, Lewis A. Quigley, Supt. Water Works, Fort Worth, Texas.

OCT. 14-16—ATLANTIC CITY, N. J. (Hotel Haddon Hall).
Pennsylvania Water Works Association. (Annual Convention.) Secretary, F. Herbert Snow, 327 Telegraph Building, Harrisburg, Pa.

OCT. 20-23—NEW ORLEANS, LA. (Hotel Roosevelt).
American Public Health Association. Exec. Secy, Dr. Reginald Atwater, 50 West 50th Street, New York, N. Y.

OCT. 22-23—SARATOGA SPRINGS, N. Y.
New York Section, A. W. W. A. (Fall Meeting.) Sec'y, R. K. Blanchard, 50 West 50th Street, New York City.

OCT. 23-24—ATLANTIC CITY, N. J. (Hotel Ambassador).
New Jersey Water Works Associations. A Joint Meeting of the N. J. Section, A. W. W. A. (P. S. Wilson, Sec'y); N. J. Water Works Association (W. C. Flanders, Sec'y); South Jersey Association of Water Superintendents (Walter Spencer, Sec'y). Chairman of Committee on Arrangements, Prof. H. N. Lendall, Rutgers University, New Brunswick, N. J.

OCT. 26-28—CHARLOTTE, N. C. (Hotel Charlotte).
North Carolina Section, A. W. W. A. Secretary, M. F. Trice, Asst. Engr., State Board of Health, Raleigh, N. C.

OCT. 26-28—KANSAS CITY, MO.
Missouri Valley Section, A. W. W. A. Secretary, Prof. Earl L. Waterman, University of Iowa, Iowa City, Ia.

OCT. 29-31—CHARLOTTESVILLE, VA.
Virginia Section, A. W. W. A. Secretary, H. W. Snidow, Senior Asst. Engr., State Dept. of Health, 601 State Office Building, Richmond, Va.

NOV. 5-7—MINNEAPOLIS, MINN. (Hotel West).
Minnesota Section, A. W. W. A. Sec'y-Treas., R. M. Finch, 416 Flour Exchange, Minneapolis, Minn. (In conjunction with Municipal Utilities.)

Unique Control of Chemical Dosage And Sludge Filtration

The following interesting adaptation of automatic and remote-controlled variable speed regulation in the exact control of chemical dosage and rate of sludge filtration at the new Perth Amboy, N. J., Sewage Treatment Plant has been recounted in an article by H. B. Diehl, noted in the December issue of the house organ of the Reeves Pulley Company of Columbus, Ind.

The article briefly describes the Perth Amboy plant and the process of sewage treatment employed, which consist of chemical precipitation, effluent filtration through a Laughlin Up-flow Magnetite Filter and sludge dewatering by drum type vacuum filters.

The unique feature of automatic control of the chemicals applied to the sewage, and the sludge dewatering operation, consists of the use of variable speed transmission equipment for that purpose. In the accompanying ilustration is seen the chemical feed equipment, the sludge filters and one-speed control unit.

In the chemical dosage control the differential head, created by the Venturi meter measuring the screened sewage, is transmitted to a sensitive pendulum diaphragm unit which operates a control potentiometer in an electrical circuit to a control cabinet. Across the whole of the potentiometer is applied 6 volts of direct current. Between the moving finger and one end of the potentiometer a voltage, proportionate to the rate of sewage flow is delivered. Opposing this voltage is another voltage generated by a tachometer-generator, mounted on a Reeves Transmission, which produces a curent of 6 volts per 1,000 revolutions per minute of the variable shaft of the unit. A galvanometer relay is connected between the potentiometer and the tachometer generator. When the voltage from the generator exactly equals that delivered by the potentiometer no current passes through the galvanometer and, so long as it stands at such neutral or off-position, the speed of the tranmission unit remains constant. As the flow through the Venturi meter changes the speed of the variable shaft of the transmission unit is automatically changed through auxiliary power relays and a Reeves Electric Automatic Control unit.

The variable speed shaft connects through a speed reducer to vary the rate of feed of chemicals to the sewage proportionate to the varying sewage flow. The dosage, thus maintained at a constant rate in pounds per million gallons, can be varied at will by hand setting of a rheostat in the potentiometer circuit which alters the ratio of "speeds to flow."

The second adaptation of control through speed variation units at Perth Amboy is found in the variable speed of revolution of the vacuum sludge dewatering units, seen in the rear of the accompanying picture. Thus can the dryness of sludge cake and output in pounds per square foot per hour of filter surface be controlled to meet conditions imposed.

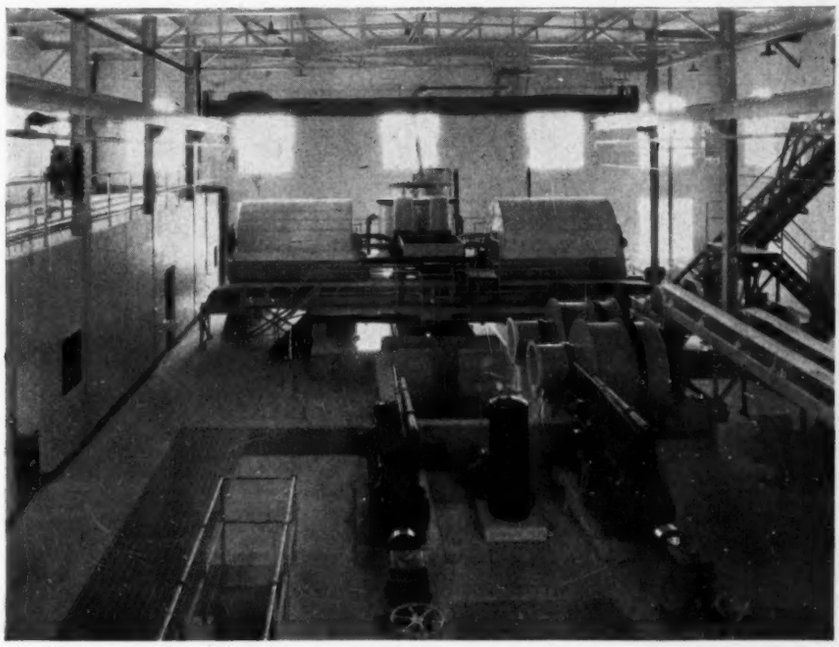
The Perth Amboy plant has duplicate equipment throughout to preclude shut down or by-passing of sewage due to possible failures. The normal capacity of the plant is 12 M.G.D., with a maximum of 20 M.G.D.

Providence to Convert Rubbish and Garbage to Power for Sewage Works Operations

The city of Providence, R. I., expects to place in operation shortly, a new and carefully engineered 160 ton incinerator plant with two 700 hp. waste heat boilers supplying two turbine-driven 1250 kw. generators. The power will be used in the city's adjacent sewage disposal plant which is being reconstructed for the activated sludge process. The power will be used to motor drive two 60 mgd and two 40 mgd pumps which are to replace the 40 year old steam engine driven units.

This constitutes an additional case of combining waste, refuse and sewage disposal toward economical ends.

The plant is being engineered by the Hiler Engineering and Construction Company, New York City, and the turbines and electrical equipment are being supplied by Westinghouse. Chas. A. McGuire is Commissioner of Public Works and Phillip J. Holton, Jr., is Mechanical Engineer of the Department.



Chemical Feed Equipment and Sludge Filters in Perth Amboy's New Sewage Treatment Plant. Automatic Speed Transmission Control Unit on Right Proportions Chemical Dosage.

Buffalo Freed of Sewer Fraud Charges

The Federal Grand Jury which has been investigating charges of fraud in connection with the Buffalo sewer projects, on July 24th returned no bills in connection with the case and thus freed the city officials of the charges.

Charges had been made that city officials had conspired, or had attempted to conspire, with consulting engineering firms previously connected with the sewerage project, for the purpose of having bids for engineering services boosted in order to cover costs to the city of promoting the project.

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UNITED STATES GEOLOGICAL SURVEY'S list of publications issued in June includes papers on the following surface water supplies: U. S. North Atlantic Slope, U. S. South Atlantic Slope and Eastern Gulf of Mexico Basins, Ohio River Basin, and North Pacific Slope.

EDITORIAL

The N. E. W. W. A. Convention

OFFICIALS of the New England Water Works Association are to be commended for their action in moving the location of the annual convention of this association to a point as far west as the constitution permits.

The reason for so doing has been to make the convention more accessible to a greater number of waterworks men. Thus, those from central, southern and eastern sections, who for various reasons were deprived from attending the distant convention of A. W. W. A., held in June on the West Coast, will have an opportunity to attend the N. E. W. W. A. Convention which has the ear-marks of being of national convention proportions. In our July issue is to be found the preliminary convention program which bespeaks itself.

Those who can come to the convention to be held in New York City at Hotel Pennsylvania on September 22-25 inclusive, will be well repaid. Indications are that there will be many present who have never before attended a N. E. W. W. A. Convention. These men will have something to look forward to—that live and spontaneous discussion from the floor, which is always enlightening and enjoyable, and for which N. E. W. W. A. is noted.

Chemical or Biological?

IN this issue are to be found two articles which discuss the potentialities and limitation of chemical methods of sewage treatment. The two authors present widely different viewpoints of the possibilities of chemical-mechanical methods of treatment, as against those depending basically upon biological phenomena. Both articles constitute valuable discussion—one by a chemist, the other by an engineer.

The article by Dr. Bach, an eminent German chemist with long experience in sewage treatment, deplores the chemical "revolution" which, apparently to his thinking, is threatening the throne of the biological-royalists. He warns of the hazard to healthful, if slow, progress in sewage treatment which has been built upon scientific principles over the years since an earlier "revolution" displaced an unscientific chemical rule to establish the scientific "bio-empire." Dr. Bach fears that sound progress, made through years of genuinely scientific research and development of biological methods ("the Nature's methods"), since the first "revolution," can be but temporarily interrupted by the present "revolutionists" who are proposing unscientific and less effective methods which are dependent upon chemical mechanical treatment alone. The latter Dr. Bach assigns to the purification of industry's wastes, while the natural (biological) must eventually win in the treatment of sewage.

From a different viewpoint, in another article in this issue, Mr. Gavett, sanitary engineer with operating and design experience in water purification and in sewage treatment, presents several aspects and evalutions of modern methods of chemical treatment of sewages and organic wastes which look to be scientifically founded and technically sound. Mr. Gavett points out the definite limitations surrounding chemical precipitation methods and the need for effective control and a clear cut understanding of coagulation phenomena, if the precipitation processes are to be most effectively and economically applied. Also, his article discusses the purification effects to be expected from agglomeration and precipitation of otherwise non-settleable portions of sewage solids. The important functions of the process in solving seasonal needs and the relative costs of varying degrees of purification per unit of work done he clearly defines: With Mr. Gavett's article his illustrative graph, picturing attainable results, supports the old Chinese axiom—"One picture is worth 10,000 words."

To us, Mr. Gavett's article has the appeal of being a scientific analysis and evaluation of the technical and economical potentialities of chemical treatment. With Dr. Bach one must agree that there has been a tendency on the part of some to overestimate the potential value of chemical methods. Also, that there has probably been too little emphasis placed on the fact that the simplicity and ease of chemical control in the coagulation of sewages is not what it is in water treatment. There is no evidence, however, to indicate that the chemical "revolution" is interfering with progress in biological treatment. Rather, there are indications that there has been a stimulus to the perfection of, and speeding up of, biological processes since the introduction anew of chemical methods. What part the re-entry of chemical methods has played in this is speculative. Beyond speculation, however, is the fact that combinations of chemical methods with biological processes is proving a decided advantage, and a happy combination. In at least one respect, therefore, the re-incarnation of chemical methods has been strengthening or supporting to biological methods, with overall results superior technically, economically, or both, to either alone.

Dr. Bach's contention that chemical methods can not transform organic matter to a stabilized or mineralized state, and therefore can not follow Nature's course in effecting the degree of purification attainable with biological processes, is non-refutable. However, that chemical methods, for partial treatment, have a definite place in the scheme of sewage treatment, as pictured by Mr. Gavett and other experienced men, seems to have passed beyond the stage of speculation and through the period of "watchful-waiting" for the results from working installations. Plants equipped for chemical treatment in one form or another, whether they be primary or complete treatment plants, have a proven flexibility and power to assimilate loadings and produce results which otherwise have not been attainable.

Without doubt, there will be grievous experiences and disappointments with chemical methods in some instances, as there have been with other methods. Likewise, there is apt to be a tendency to follow the style and install chemical treatment where illy advised, just as has been done with other methods as they come into style in the past. However, with proper understanding and display of judgment, the short-comings of chemical methods will probably be no more numerous or serious than those of biological methods. An analysis of all local factors is more important today than ever before, when it comes to the selection of the method of sewage treatment most suitable, economical and practical for a given situation. In this, the engineer has more "tools" at his disposal today than ever before, but this does not in any degree relieve him of the ever present responsibility of distinguishing between fact and fancy and, in the end, choosing soundly.

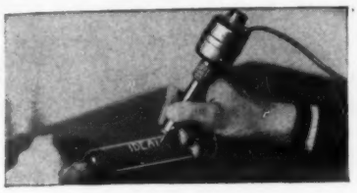
We do not believe the question is "Chemical or Biological?" Instead; it should be "Where Chemical and Where Biological?" In sewage treatment as in other developments this saying is equally true, "when you are through changing—you *are through.*"

EQUIPMENT NEWS

Electric Marking Tool

The Ideal Electric Marker, a new and inexpensive portable tool for marking on practically any material, whether metal or non-conductor, has been announced by the Ideal Commutator Dresser Company.

With this handy "tool" one may etch or cut the owner's name or initials on tools or equipment; inscribe manufacturer's name, price stock number or trade name on various products; apply identifying marks on parts in store rooms; etch company name, sizes, etc., on tools in the tool room; mark glass ware; and



Ideal Electric Marker

a variety of other uses. Slogan—"The Ideal Marks *Anything* and *Everything.*"

The new marker is a handy size, as illustrated; comes complete and ready for use; operates on 110 volt 60 cycle A.C. and consumes approximately 75 watts. It can, also, be furnished for other standard voltages and frequencies.

For illustrated literature address, Ideal Commutator Dresser Company, 1615 Park Ave., Sycamore, Ill.

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Truckair Compressor

The Sullivan Machinery Company of Michigan City, Ind., are offering a new compressor unit designed specifically for truck mounting, with power take-off from the propeller shaft and so utilize the truck engine for drive. The compressor is a two stage air-cooled unit with a capacity of 105 C.F.M. delivered.

The Truckair

Features stressed are; force feed lubrication, anti-friction main bearings; automatic control; small space requirements (see cut) so that the major part of truck space can be utilized to carry men, tools and materials. Of added interest is the special vacuum hood which makes possible the pulling of a vacuum where desired.

For a better description, request Bulletin A-14. Address Sullivan Machinery Company (Dept. W.S.), Michigan City, Ind.

C-H Pressure Switch

A new Pressure Switch for the automatic control of pumps and compressors has been announced by Cutler-Hammer, Inc., well known as pioneer manufacturers of electric control apparatus.

Although the switch is completely new in design, the basic mechanism has been time-tested by its use in millions of domestic refrigerators. Inverse time limit over-load protection is obtained by the C-H Eutectic Metal Thermal Overload Relay, operating directly on the contact mechanism. The relay gives protection to the motor when starting and running. It also allows an ample time interval to take care of starting inrush or momentary overloads without tripping. A red band on the reset button indicates when the switch is open and equipment shut down; pressing the button resets the overload, places the starter back in service. By simply pulling out the reset button the equipment can be shut down. The split type enclosing case and design of the mechanism permits easy access to terminals and adjustment screws.

Outstanding features of this new pressure-switch, as listed by the manufacturer, are: Compactness of its all metal "air-styled" enclosing case; flexibility of application; long, trouble-free operation; full automatic action; protection to motor; ease of wiring and adjusting and inspection.

New Cutler-Hammer Pressure Switch

Pressure connection for S.A.E. fitting is furnished as standard, but may easily and quickly be converted into ¼ or ⅜ inch pipe fitting.

For descriptive literature address Cutler-Hammer, Inc. (Dept. W.S.), North 12th St., Milwaukee, Wis.

▼

Super-Seal Packing

"Super-Seal" is a new dry-graphite lubricated, plastic packing recently developed by the Crane Packing Company of Chicago.

"Super-Seal," which is offered as a general all-service packing in six different forms, is composed basically of extremely fine particles of a new alloy perfected through exhaustive experimentation and testing. The special high-temperature resistant binder, which contains the purest of flake graphites, completely covers and saturates each particle of alloy and every strand of the long-fibre asbestos. Thereby is assured perfect dry-graphite lubrication so long as there is any packing in the box or gland. The manufacturer claims that "Super-Seal" retains its resilience, will not harden or dry-out. Further, that it flows readily under gland pressure, making it adaptable for the smallest to the largest size packing spaces.

Crane Packing Co.'s Super Seal

Of particular interest, amongst the six different forms, is the spiral form (rectangular shape) which the use of the new alloy has made possible. For the first time a plastic packing in spiral form has been made available and practical.

In a well-prepared illustrated bulletin "Super-Seal" packings are clearly pictured and described as to qualities, services and sizes. For a copy address Crane Packing Company, 1816F, Cuyler Ave., Chicago, Ill.

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Clyde Hum Joins Pittsburgh Meter

Clyde Hum

Pittsburgh Equitable Meter company and its subsidiary, Merco Nordstrom Valve Company, announce that Mr. Clyde Hum has recently been appointed to its Chicago office sales force. He will represent these companies in Indiana and Illinois.

Graduated by the University of Michigan, Mr. Hum then served in the World War. Thereafter he became City Manager of Grosse Point, Mich. He was then successively with the Ehres Fox Fire Engine Company and the Eureka Hose Company, leaving there after eleven years' employment to join Pittsburgh Meter Company.

▼

Snodgrass Made Sales Manager for Imperial Electric

George M. Snodgrass, widely known in the electrical industry, has recently been appointed general sales manager of the Imperial Electric Company of Akron, Ohio, manufacturers of electric motors and generators. For the past 15 years he has been with Fairbanks-Morse & Company where he advanced to the position of general sales manager of the Electrical Division.

Easy Handling

Ferrisul can be handled in ordinary dry feeders, and stored in concrete bins, with no melting in summer or freezing in winter. It requires a minimum of control, and provides a quick-forming, rapid-settling ferric iron floc without the addition of other chemicals. The floc is stable over the entire pH range from 3.5 up. Write for new Ferrisul booklet, or consult us in regard to your specific problems. MERRIMAC CHEMICAL CO., Everett Station, Boston, Mass. (*A subsidiary of* MONSANTO CHEMICAL CO.)

Ferrisul
FOR WATER AND SEWAGE TREATMENT

CATALOGS AND LITERATURE RECEIVED:

"Pipe Couplings and Repair Devices":—From S. R. Dresser Manufacturing Company has been received an outstanding catalog of 172 pages which, in addition to serving as a catalog, is in reality a reference book. It is excellently illustrated and descriptive of the large variety of Dresser Couplings, Fittings, Clamps, Split Sleeves, etc. In a comprehensive but non-technical manner the "Essential Qualities of a Pipe Joint" are discussed and there are 32 pages of a variety of pipe line views. The numerous illustrations of construction details and dimensions of all Dresser pipe line products are excellent and complete. Directions for installation and ordering are clearly set forth. The Catalog section proper covers 106 pages and beyond it are several pages of "Tables of Useful Information," followed by a complete and helpful index.

In every respect a worth-while-having production, is the expensively produced Dresser Catalog No. 36. For a copy address S. R. Dresser Manufacturing Company, Bradford, Pa.

"The Airveyor":—Is the title of Fuller Company's new catalog which illustrates and describes "Airveyor" equipment for pneumatically conveying fine crushed or granular materials. Especially useful in the water works and sewerage field for unloading, storing and rehandling chemicals purchased in bulk, at appreciable savings in delivered costs, the adaptation of pneumatic conveying equipment to modern plants is receiving justified attention. Cleanly, and money saving installations at small and large water purification plants are illustrated. For "The Airveyor" and more detailed information on pneumatic conveyor equipment, address Fuller Company Catasauqua, Pa.

"Powdered Hydrodarco":—Darco Corporation, for many years producers of granular "Hydrodarco" (activated carbon for use in contact filters) have recently distributed a booklet announcing the availability of powdered "Hydrodarco," which is offered as an improved product and "an innovation in activated carbons." The booklet sets forth the claims of the new "Powdered Hydrodarco" to supremacy as a scientifically "designed" activated carbon for a special duty, namely, water purification. For a copy address Darco Corporation (Dept. W.S.), 60 East 42nd St., New York, N. Y.

"Solving Acid Problems":—Is the title of a bulletin from the Atlas Mineral Products Company. It recounts and pictures methods of lining concrete or steel tanks with acid-proof brick or vitrified liner plates jointed with "Tegul-VITROBOND," an improved sulphur cement now successfully used in lining acid tanks and chemical solution tanks. Proven in industrial plants "Tegul-VITROBOND" should be of interest to water works and sewerage engineers confronted with the construction of acid proof tanks for ferric chloride and the like. Also for protection of sewers where sewer gas and acid attack is already a problem, or is likely to be. Ask for "Solving Acid Problems with Tegul-VITROBOND." Address Atlas Mineral Products Company, Mertztown, Pa.

"REX Sewerage Equipment":—From Chain Belt

Company have been received bulletins descriptive of "REX Mechanically Cleaned Bar Screens" and "REX Plunger Sludge Pumps." The first illustrates and lists the outstanding features of the improved REX Bar Screens with open bars and long life Z-metal chains and attachments. The second illustrates and lists 10 outstanding features exclusive to the well known REX Sludge Pumps, which are non-clogging, positive in action, and flexible. It has easily adjustable stroke crank and is operated with a multi-speed motor to secure the desired rate of sludge pumpage, with all ports and valves on the circuit wide open. For copies of either or both of these REX bulletins address Chain Belt Company (Sanitation Dept.), Milwaukee, Wis.

"Super-Seal":—Is a bulletin describing and illustrating the new "John Crane" plastic packings which employ a special alloy, making possible the offering of six forms, including a plastic packing in spiral form for the first time. (See "Equipment News," this issue.) For a copy of "Super-Seal Packings" address Crane Packing Company, 1816 F. Cuyler Ave., Chicago, Ill.

"Morris Sewage Pumps":—In a new bulletin Morris Non-Clogging Pumps for Sewage and pulpy materials are described in detail and illustrated. The particular vertical and horizontal pumps described have sleeve bearings and supplement the well known line of Morris Non-Clogging Pumps with ball bearings for higher speed service. For a copy of Bulletin 161 address Morris Machine Works, Baldwinsville, N. Y.

"Flexrock":—The Flexrock Company have a new leaflet descriptive of the flexible concrete—"Flexrock"—which has the combined advantages of wood and concrete when used in repairing or covering old floors or laying new floors. Directions for the mixing and application of "Flexrock" are given. Advantages claimed are that the finished floor is lighter than concrete (2 lbs. per sq. ft.); to the feet, is like wood; hardens quickly; looks like concrete, but is tough and flexible. For the leaflet "Flexrock" address Flexrock Company, 800 North Delaware Ave., Philadelphia, Pa.

"Bilton Pumps":—In a bulletin just received from Byron Jackson Company is described their general utility line of side suction Bilton Pumps in smaller sizes for horizontal, vertical or incline operation. The pump and splash-proof motor come as a compact single unit without flexible coupling or base plate. Are especially suitable for use where little space is available; as recirculating pumps for hot or cold water; and in general service. These units also come equipped with explosion proof motors where desired. Detail cuts, specifications and rating data clearly picture the pump, its special features and what it will do. For a copy of Byron Jackson Bilton Pumps (Bul. No. 360-B) address Byron Jackson Company, Berkeley, Calif.

"Dangerous Water Ahead?":—Is the title of a recent Mathieson Alkali folder which tells of the value of their "H.T.H." (High Test Hypochlorite in powder form in hermetically sealed cans) for general use in sterilization practices in water works operations. More especially are described emergency uses of this powerful and concentrated sterilizer, which may be safely stored without deterioration, for use on a moment's notice when unusual or emergency conditions arise. Actual illustrated experiences and opinions of operators, having used "H.T.H.," are set forth. For this folder or other information concerning "H.T.H." address Mathieson Alkali Works, Inc., Box 408, Grand Central Sta., New York City.

Here's the best news you've heard in years about small Cast Iron pipe. McWane is casting 2" pipe in 9-foot lengths . . . instead of 6. That means *one* intermediate joint, instead of two, in each 18-foot length. That also means less friction . . . and faster, more economical installation.

Less joints! Less friction! but the same full 2" internal diameter that means maximum flow . . . and the same high tensile and transverse strengths which makes it easy to lay McWane 2" around curves without fittings.

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2½" OVERSIZE M.&F. THREADED JOINT

50% LESS JOINTS

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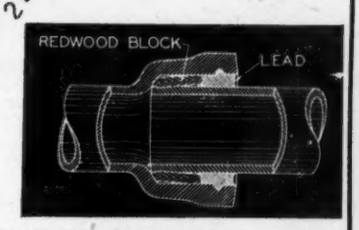

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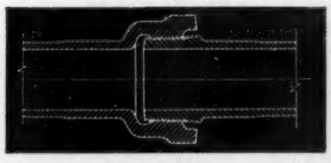
Nothing to buy. No lead pouring. The Pre-calked Joint is already in the bell, ready to finish on the job. Just socket the spigot and finish calking. Simple! Self-tightening! Permanent!



McWANE OVERSIZE MALE AND FEMALE THREADED JOINT is always the intermediate joint in these factory assembled 18-foot lengths for it is the **only** joint as permanent as the pipe itself.

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Beautifully illustrated, it describes the outstanding design and construction principles which have made Victor-Kimball-Krogh Deep-Well Turbine pumps acknowledged leaders in their field. Write for it today.

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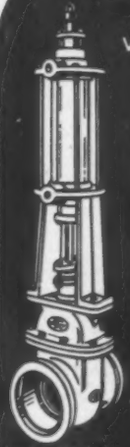

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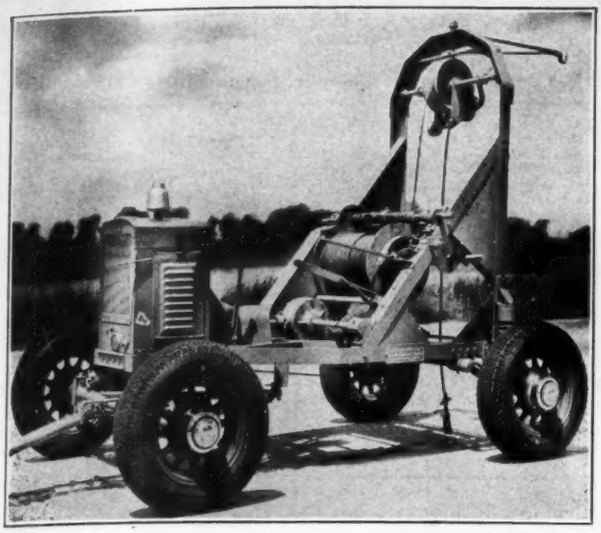
SEWER CLEANERS



O.K. Champion Sewer Cleaners have passed their 25th year of satisfactory performance. We now make three sizes—Junior—Standard and Power Cleaners. Hundreds of O K Champion Cleaners are in use in 42 States and Canada.

The Power Cleaner illustrated above is working to the entire satisfaction of the purchasers in Atlantic City, N. J., Little Rock, Ark., and others.

We solicit your inquiries for literature and prices. Deliveries can be made promptly.

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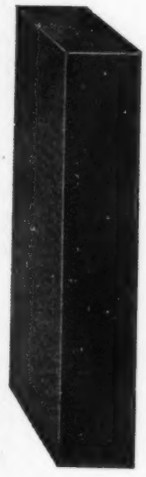

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Remember, when you are planning your new sewage plant, swimming pool or in fact any type of concrete structure, that the life of that structure depends on the joint filler you employ.

SERVICISED EXPANSION JOINTS are made to exacting specifications. Furnished in various types, such as Premoulded Asphalt, Cork Rubber, Sponge Rubber, Plain Cork, and many other types. They are made to prevent and control cracking of concrete, giving longer life to concrete construction however or wherever used.

Specify — SERVICISED Expansion Joints on your next concrete job.

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They wont balance because of "S-O"

SEWER ODORS creep in *everywhere*—and sooner or later they show up in the community finances... all because of hydrogen sulphide, the obnoxious gas generated by sewage bacteria. When the gas escapes, the voters complain. When it stays in sewer lines it generates sulphuric acid—and that's where trouble begins.

The acid attacks the lime in the mortar and cement of sewer walls. Before long the whole sewer may be gone. This has actually happened in more than one California community, even before the sewers were paid for!

But you can avoid "S-O" and the danger to sewer lines, by chlorinating the sewage with Bear Brand Chlorine, as a score of other California communities are doing. Chlorine neutralizes the existing gas before it can form acid, and kills the sewage bacteria which generate the gas. No more odors, no more danger.

Both initial cost and upkeep of chlorinating equipment are low. And chlorination may save on sewage treatment plant operating costs, because chlorination often increases plant efficiency. This means faster treatment, increased plant capacity... Why not talk to our sanitary engineers about sewage treatment with Bear Brand Chlorine? No charge or obligation.

Send for "Use of Chemicals in Sewage Treatment": We'll be glad to send you, without charge, a reprint of this article by R. A. Stevenson, telling how chemicals are used in successful treatment of sewage.

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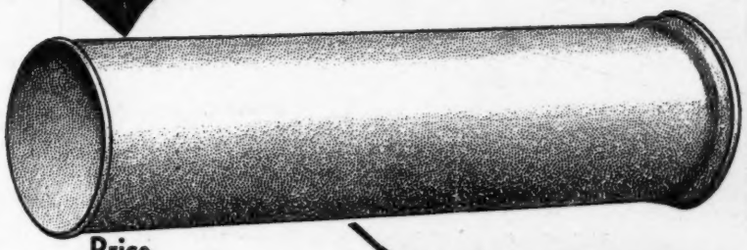

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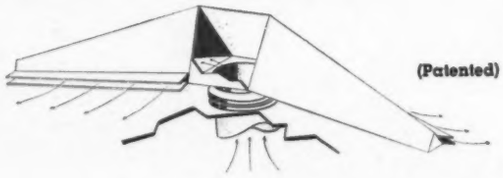

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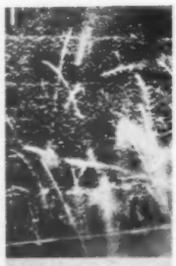

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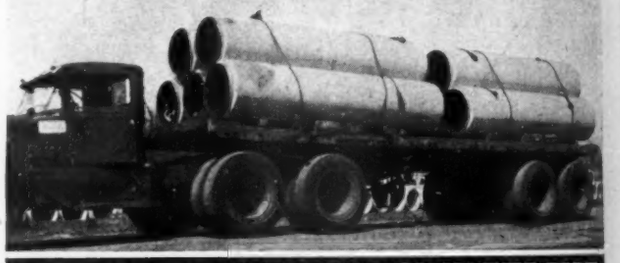

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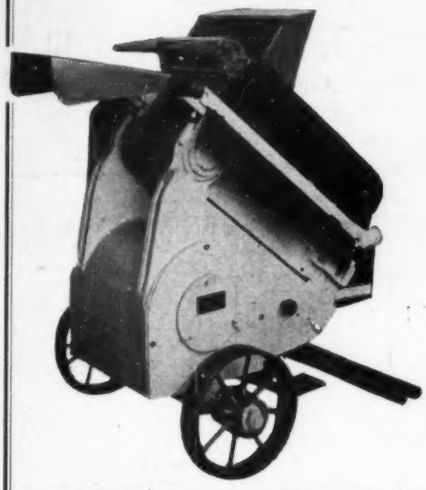

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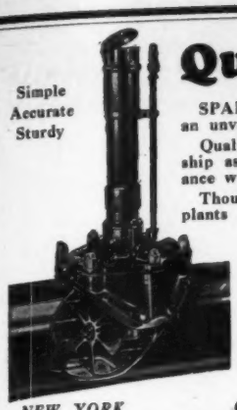

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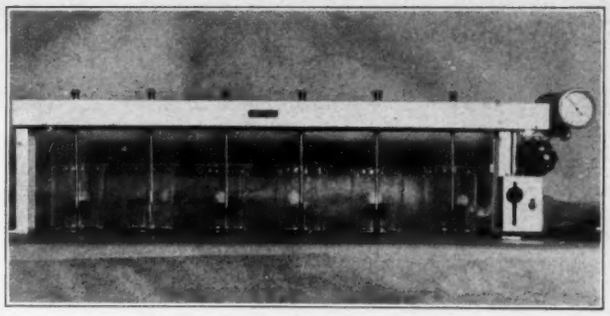

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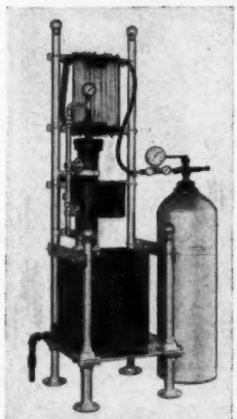

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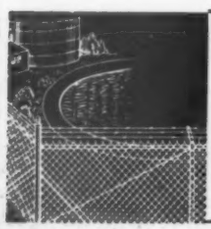

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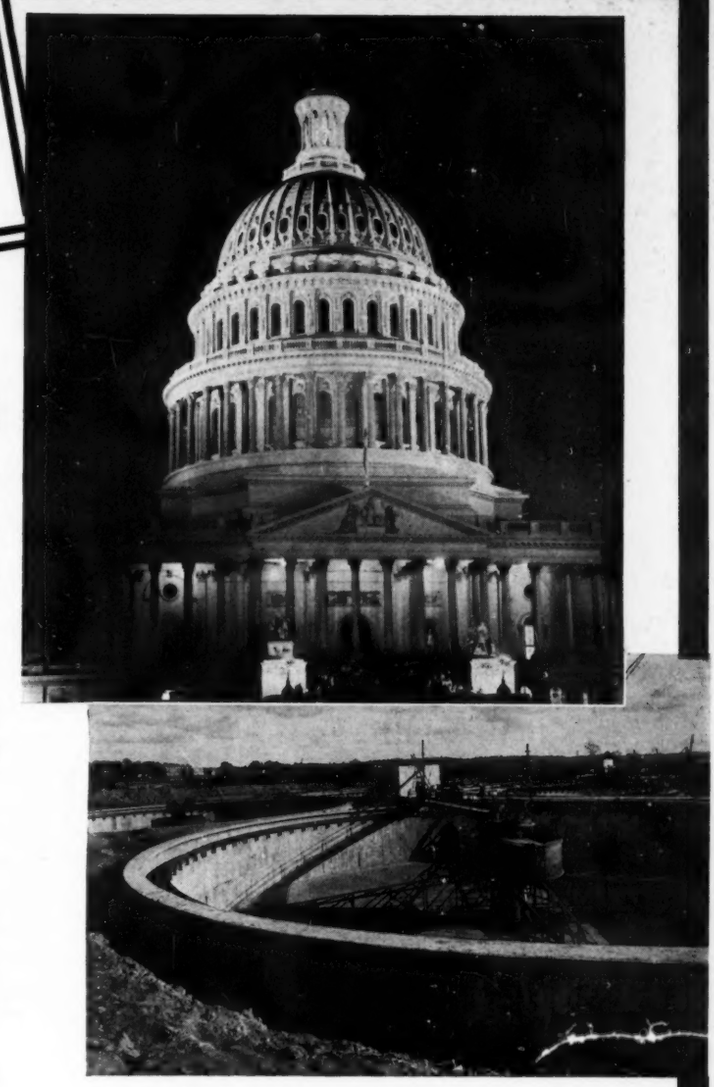
FOR THE NATION'S CAPITAL

12 - 106 ft. DORR SIFEED CLARIFIERS

Not many miles from the dome of the Capitol, Washington's new separate sludge digestion plant at Blue Plains, D. C., financed by P.W.A. funds, is rapidly being completed by John W. Cowper Company, general contractors. The District of Columbia's board of engineers, reporting on this project, consisted of Metcalf & Eddy of Boston, John H. Gregory of Baltimore, and Greeley & Hansen of Chicago.

Significantly, 12 Dorr Sifeed Clarifiers, each 106 ft. in diameter, were selected for settling Washington's ultimate flow of 130 MGD. Dorr engineers, too, have been engaged to supervise the erection and to supervise the initial operation of these clarifiers during the crucial breaking-in period.

The Dorr Company, with an installed capacity of over 3 billion gallons a day, has pioneered virtually every advance in the mechanical handling and treatment of domestic sewage since 1914. That is but one of the reasons why Dorr equipment has been chosen for the country's largest plants at Chicago, New York, Cleveland, Los Angeles, Baltimore, and Washington.



Construction picture of Washington's new sewage treatment plant.

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*"Timon of Athens."

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